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OBSERVATIONS ON THE MODE OF ACTION OF CONTACT INSECTICIDES[1]

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During the present year, certain experiments have been conducted, which throw further light on the action of contact insecticides, and since it does not appear possible to make a more complete study in the near future, the following brief account is given in the hope that it will prove of some value to entomologists.

In a recent paper on essential physical properties of contact insecticides,[2] it was shown that fat solvents, oils and soaps were able to penetrate the tracheæ of insects by capillarity. It was further noted that heavy, practically nonvolatile and nontoxic oils, which had thus penetrated the tracheæ caused the death of the insects, but that the tissues of such insects were not stained by trypan blue (which stains dead tissue and not living tissues) until, ten, twenty or more hours had elapsed. From these observations, the question arose as to whether the insects did not die from the lack of oxygen resulting from the closing of the tracheæ. Shafer[3] has shown that methylene blue or indigo carmine injected into the body of an insect, which is then placed in an atmosphere free of oxygen, is reduced to its leuco compound and the body of the insect again becomes white or yellowish white. Upon

[1] Published with the approval of the Director as Paper No. 141, of the Journal Series of the Minnesota Agricultural Experiment Station.

[2] Moore, Wm., and Graham, S. A. Physical Properties governing the efficacy of Contact Insecticides. Journ. of Agr. Res. Vol. xiii, No. 11, 1918, pp. 523-538.

[3] Shafer, Geo. D. How Contact Insecticides Kill. Mich. Agri. Exp. Sta. Tech. Bull., 11-65 p., 1911.

being removed to the air, the stain is again oxidized and the body of the insect becomes blue. The following experiments were conducted to determine if treatment with an insecticide capable of plugging the tracheæ would thus reduce methylene blue.

Exp. 1. Larvæ of waxmoth (*Golleria mellonella*) were injected, with a saturated solution of methylene blue by means of a fine glass tube. Some of the larvæ were left as checks while others were dipped in a light lubricating oil. Larvæ not treated with the oil remained a beautiful blue while those treated, rapidly faded out, becoming white or yellowish white in three to five minutes. Since it was impossible to remove the oil from the tracheæ, the larvæ were then opened with a pair of scissors. The tissues and body fluids immediately turned blue on contact with the air.

Exp. 2. Same as Experiment 1 but when larvæ had become white, some of its body fluids were carefully removed by a capillary tube. A drop of this blood placed on a piece of filter paper or on a glass slide assumed a blue color in a few minutes.

Exp. 3. Same as Experiment 1 but olive oil used instead of a lubricating oil. Results exactly similar were obtained.

Exp. 4. Larvæ injected with methylene blue and then with olive oil. Although the larvæ died in a few hours, it remained blue both before and after death.

Exp. 5. Heavy lubricating oil, so viscous that it was unable to penetrate the tracheæ, was used to cover over a larva previously injected with methylene blue. Larva moved about for four hours, retaining its blue color, after which it was buried under a thicker layer of the oil with the result that it lost its blue color and was stupified within one hour. The oil was then removed as well as possible, but although the larvæ again assumed a bluish color, it did not survive the treatment.

Exp. 6. Injected larvæ dipped in toluene and removed; decolorized in six minutes. Injected larvæ dipped in carbon tetrachloride and removed; decolorized in six minutes. Injected larvæ dipped in xylene and removed; decolorized in seven minutes. Injected larvæ dipped in nitrobenzene and removed; decolorized in seven minutes. Injected larvæ dipped in nicotine and removed; decolorized in six minutes. Injected larvæ dipped in ether and removed; redipped, decolorized in thirty minutes.

Exp. 7. Injected larvæ placed in small vial with vapor of nicotine. Larvæ dead in four hours but color had not faded. Larvæ kept twelve hours but blue color did not fade.

Exp. 8. Experiment 7 repeated, using nitrobenzene and xylene with similar results.

Exp. 9. Injected larvæ placed in water, which did not enter the tracheæ. Started at 9.15 a. m., decolorized 9.28 a. m. Removed and excess water absorbed with filter paper. Larvæ again blue in color at 9.32 a. m. Larvæ were returned to the water at 9.40 a. m. and left until 2.10 p. m. They turned blue at once upon removal to the air.

Exp. 10. Injected larva placed in soap solution 1–500 in such manner that only the right spiracles were in contact with the soap. Removed and placed in pure water until colorless. Removed from water, dried, and left half of larva assumed a blue color while the right side remained colorless. Heart not beating and larva in stupor. Placed completely in soap solution and color faded out but did not reappear when larva was again dried and exposed to the air.

Exp. 11. Injected larva placed in soap solution until color had disappeared. Removed at 9.40 a. m. and color not having reappeared by 10.02 a. m. it was placed in distilled water and thoroughly washed until 10.20 a. m. Removed but color did not reappear by 10.37 a. m.

Exp. 12. One injected larva dipped in light lubricating oil so as to fill treacheæ of cephalic portion and another dipped to fill tracheæ of caudal end. Removed, heart beating and larvæ did not lose its blue color. Placed in water until stupefied and heart had ceased to beat. Larvæ now colorless were removed to the air and dried, when the portion with oil filled tracheæ remained colorless while the other half of the larvæ assumed a bright blue color. Later the larvæ revived, the heart started beating and the whole larvæ became blue.

Exp. 13. Injected larva placed in soap solution becoming colorless. Removed, carefully washed in distilled water and rolled on filter paper to remove as much as possible of the soap solution from the tracheæ. Within an hour, a bluish color developed in the vicinity of each spiracle, until after ten hours, the larva was irregularly blue over the entire body.

These experiments show that a contact insecticide containing oil or soap may penetrate the tracheæ of the insect; thus preventing normal oxidations from taking place in the insect's body with the result that the insect dies from their mechanical action alone. In order to insure death in this manner, it is necessary that all the tracheæ be filled with the spray. The vapor of the insecticide such as nicotine may produce death by chemical action without materially influencing the intake of oxygen. For small insects such as plant lice, an insecticide killing in a mechanical way alone will give good results, since all or nearly all the tracheæ will be filled. For larger insects, such as the tarnished plant bug (*Lygus pratensis* L.) filling all of the tracheæ becomes unlikely, hence it would be necessary to add to the spray an insecticide capable of killing in a chemical manner, thus insuring death, even if only one trachea is filled. Field experiments with sprays containing free nicotine have shown that the efficacy of such sprays is sometimes increased 50 per cent. by the addition of soap. These experiments were conducted during the past summer by S. A. Graham and will be reported by him elsewhere.

A further point, however, which has a decided bearing upon this question, arose in the study of the effect of laundering processes upon the destruction of active stages of the clothes louse (*Pediculus corporis*). In these experiments it was shown that the clothes louse was able to close its tracheæ quickly enough to keep out soap solutions, lubricating oils, xylene, and in seven cases out of twelve, even ether was prevented from entering. A few experiments have shown that the hog louse (*Hæmatopinus suis*) and the dog louse (*Hæmatopinus piliferus*) possess a similar power of keeping ether out of their tracheæ, but are not as successful in general as the clothes louse. The dog flea (*Pulex serraticeps*), mealy bugs (*Pseudococcus sp.*), soft scale (*Coccus* sp.), houseflies (*Musca domestica*), angumois grain moth, larvæ and adults (*Sitotroga cerealella*), tussock moth larvæ (*Notolophus leucostigma*) and pea aphis (*Macrosiphum pisi* Kalt) were all unable to prevent the penetra-

tion of ether, but this does not mean that some of these might not be able to shut out heavy oils or soap solutions. This whole question is interesting and if the parasitic lice, ticks, etc., should be found to possess this ability of closing the tracheæ rapidly, it will have considerable bearing upon the type of dips which would prove most effective. A similar cause may be an explanation of the difficulty of killing such insects as the tarnished plant bug. It is hoped to give this problem further attention at some future date.

THE CALIFORNIA PISTOL CASE BEARER[1]

COLEOPHORA SACRAMENTA HEINRICH

By W. M. Davidson, *U. S. Bureau of Entomology, Sacramento, Cal.*

Coleophora sacramenta Heinrich, Insec. Insci. Mens. II p. 145, 1915.

Coleophora sacramenta Hein.; Essig, E. O. Injurious & Beneficial Insects of California: Suppl. Monthly Bull. IV, 4. 1915.

Introduction

Since the year 1908, observations on the habits and biology of this insect have been made by agents of the Bureau of Entomology, Deciduous Fruit Insect Division, under the direction of Dr. A. L. Quaintance. The material in this paper has been arranged from notes made by Mr. J. R. Horton, Bureau of Entomology, formerly in the Deciduous Fruit Insect Division, by Mr. P. R. Jones, formerly of the Bureau of Entomology, Deciduous Fruit Insect Division, and by the writer. The greater part of the observations were made at San José, Cal., during the years 1910–1912, while some points in the life-history were subsequently checked up in 1916 at Walnut Creek, California.

Related Insects

The California Pistol Case Bearer belongs to a group of moths (Elachistidæ) of which a number are injurious to deciduous fruit trees. Among these are the Cigar Case Bearer (*Coleophora fletcherella* Fernald) the Western Cigar Case Bearer (*C. volckei* Volck) and the Eastern Pistol Case Bearer (*C. malivorella* Riley). The last named which attacks pomaceous fruit trees in the East is very similar to *C. sacramenta* in appearance and habits. According to Lowe[2] there are some minor differences; the larvæ of *C. malivorella* pupate on the twigs and branches, not on the leaves as in the case of *C. sacramenta*; the egg and pupal instars of *malivorella* in New York are passed in from 10 to 14 days, whereas those of *C. sacramenta* in California require a period of some 25 days.

[1] Published with the permission of the Secretary of Agriculture.

[2] Lowe, V. H. Bulletin 122, N. Y. Agr. Exp. Sta., Geneva, N. Y.

Distribution

The insect appears to be confined to the San Francisco Bay region and to the counties of Santa Clara, Santa Cruz, Contra Costa, San Mateo and Alameda. In the Santa Clara Valley the species is at times quite abundant. In the San Ramon Valley in Contra Costa County it appears to be quite rare and has perhaps only been recently established.

Food Plants

These include plum, prune, cherry, apricot and apple. Decided preference is given to cherry, and plums (including prunes) of the European type.

Injury

Injury is caused by the larvæ only. Instances in which it has been damaging are few. The young larvæ from June to September skeletonize the foliage, feeding at first as leaf-miners. Old larvæ from late February to May attack leaf buds, fruit buds, flowers, foliage and occasionally the young fruit. When the larvæ are abundant they may destroy an appreciable number of fruit buds and blossoms, but in general, cherries and plums blossom so profusely that the buds and flowers destroyed by the case-bearers are a negligible quantity. Small brown scars are formed on the fruit.

General Biology

There is one generation a year. The adult moths emerge in May and June; the female after copulation deposits her eggs on the leaves of the food-plants. The eggs hatch after an interval of 26 days, the maximum date of hatching being about July 1. The young larva sets about constructing its "case" and once built this is never cast off but gradually enlarged as the larva inside grows. In their first instar the larvæ feed on the soft inner tissues of the leaf and skeletonize it. They feed thus until September and then proceed to the twigs and limbs to hibernate. Hibernation proceeds through the month of September, the larva fastening its case to the bark surface with a silken button. About the time when the buds are swelling in spring the larvæ resume active life and move to the young growth, feeding first upon the opening buds and later on the young leaves and fruit. When full grown they fasten their case to the leaf surface and pupate. Pupation occurs in April and May and after a lapse of 25 days the adult moths split apart the valve-like butt of the "pistol" and issue. From measurements taken periodically it appears that the larvæ molt once in the fall and twice in the spring previous to the pupal molt. Just

before each molt the larvæ fasten the case to the plant surface in the same manner as they do at hibernation and before pupating turn around inside the case so that the head of the pupa shall lie away from the plant surface.

Biological Records

Adult Emergence. In the cages in 1909, adults issued as early as May 18 and as late as June 25. Emergence reached its maximum between May 29 and June 4, and by June 1 half the total number (125) of moths under observation had emerged. In 1910 emergence took place on dates practically similar to those the year before. In 1911 and 1912 the emergence was slightly later, while in 1916 it occurred between May 9 and June 3.

Habits of the Moths, and Egg Deposition. The moths are present from about the middle of May to the middle of July. They are rarely seen flying in the sunlight and when disturbed on the trees they soon seek refuge from the light. How long the moths may live in nature is not known, but in cages in which there was no food they existed for as much as a week.

The eggs are deposited on both sides of the leaf, but mostly on the upper surface. Deposition has been observed to take place throughout the day. On July 9, 1909, 146 apricot leaves were examined, and it was found that 431 eggs were on the upper side and 134 on the under side. Eggs were found on the upper side of 102 leaves and on the lower side of 56. On the upper side the greatest number of eggs per leaf was 22, on the lower side 8. There were on the average 3 eggs on the upper side of each leaf and .92 on the under side. On the same date there were 28 recently hatched larvæ on the upper sides, and 171 on the lower sides, of the same leaves. The locations of the eggshells from which these larvæ had issued were not noted but as the larvæ upon hatching mostly seek the under side of the leaf it is doubtful if the relative positions of the eggs would have been materially changed had the shells been counted. The leaves above mentioned were taken from caged trees and were much more heavily infested than has ever been observed in nature.

Incubation. The following table indicates the period of incubation in 1910 at San José, California.

A total of 244 eggs passed the incubation stage in an average of 26.1 days, the maximum and minimum being respectively 30 and 18 days. Five hundred and ten eggs were laid under observation and thus almost 48 per cent hatched. The dark head of the larva is visible about 4 days before hatching.

TABLE I. INCUBATION, SAN JOSE, CALIFORNIA, 1910

Cage No.	No. Eggs	Date of Deposition	Date of Hatching	Length of Egg Stage, Days
1	4	May 24	June 11	18
	11	25	13	19
	3	25	14	20
101	1	31	24	24
	1	31	25	25
	3	31	26	26
	2	31	27	27
	1	31	28	28
102	3	31	25	25
103	3	31	25	25
	6	31	30	30
105	1	31	28	28
107	3	June 1	30	29
108	4	1	30	29
113	29	8	July 5	27
	42	8	6	28
	24	8	7	29
114	5	June 10	July 6	26
	21	10	7	27
116	6	12	8	26
	7	13	9	26
	1	13	10	27
	12	14	8	24
	7	14	9	25
	1	14	10	26
	1	14	12	28
	11	15	9	24
	5	15	12	27
	19	16	9	23
	7	16	12	26

Dates of Hatching. In 1910 hatching commenced about June 11 and continued until the middle of July. In 1911 on experimental trees the hatching period extended until the end of July. Judging by the records year by year, the hatching period may be said to embrace the months of June and July and to reach its maximum about the end of June.

Larva. Upon hatching from the egg the young larva bores into the leaf underneath the eggshell and thus protected, begins building its "case." A silken cream-colored cylinder is first constructed around the body and the outside is next lined with frass and granular matter. When the larva is about three weeks old the "wings" of the case are apparent. These wings are two flaps occurring near the apex of the case, one on either side of the median slit. After their formation they are much more apparent in the young than in the old stages, and they stand out from the body of the case in such a manner as to give the whole object when viewed from above the shape of a broad arrow head. Later they become closely appressed to the body of the case and with the rounded apex tend to give to the whole the appearance of a pistol. The color of the young case is dark brown and opaque, while the fully-formed case is a grayish-black and is somewhat polished.

The young larvæ (Pl. 15, fig. 1) station themselves mostly on the under surface and skeletonize the foliage, molting once in the fall. They feed thus until September and during this month proceed to the

twigs and limbs to attach their cases for hibernation. The case is fastened to the bark surface by means of a silken pad or button and thereafter the larva remains dormant until the following February or March. Hibernating cases measure about 3 to 4 mm. in length, with an apical width of about 1.6 mm., and the larvæ inside span about 4 mm. A large percentage of larvæ die during the dormant period.

Activity in spring appears to be governed by climatic conditions and by the sap flow of the host plant. On a young Myrobalan tree under constant observation in 1912, it was found that the larvæ commenced feeding about February 18, but all had not become active until March 21. In 1909 the commencement of activity on cherry trees continued throughout March and into April. The larvæ were observed to feed from March 7, at first eating the unopened buds and later the young foliage as it pushed forth. In 1910 and 1911 the young case-bearers started feeding on plum, apricot and cherry about the time when the young leaves began to appear, roughly about March 20. In 1916, an early season, larvæ were working on plum and cherry before March, and observations made on March 6 indicated that two-thirds had commenced feeding.

From measurements of larvæ collected in March it appears that a molt takes place shortly after they recommence feeding in spring and that a second occurs soon after. Thus on March 25 and 29, 1912, two lots of larvæ were collected, one of which had an average head width of .53 mm., and the other of .84 mm., the head width of hibernating individuals being in the neighborhood of .38 mm.

In 1912 the earliest larvæ cast their second spring molt before March 25 and on April 22 it was estimated from collections that about half the individuals had cast this molt and that about 2.5 per cent had attached their cases preparatory to pupating. A considerable number of larvæ must have been almost as far developed, for on April 27 it was found that 40 per cent had turned around in their cases. Very shortly after this date pupæ were found and the latest larvæ pupated not after May 20.

The above observations were made on a large series of case-bearers confined in a large cage over a Myrobalan plum tree.

In 1909 collections of pistol-case bearers were made in prune and cherry orchards during May, and specimens which had been collected in March and caged on apricot were also examined. One such lot reared on apricot was examined May 6; the occupants of 71 cases consisted of 4 active larvæ, 31 dead or inactive larvæ, and 36 pupæ. In a lot of 105 cases collected from prune May 8 there were on May 10, 4 living larvæ, 7 dead or inactive larvæ, 63 pupæ, and 31 parasitized larvæ. In another lot of 47 cases, collected from cherry May 8 and

examined May 10, there were 9 living larvæ, 12 dead or inactive larvæ, 23 pupæ, and 3 parasitized. On May 20, a lot of 59 cases was taken from prune and cherry; these consisted of 8 inactive larvæ, 1 dead larva, 43 pupæ, and 7 parasitized. On May 24, only pupæ were collected, and a few early moths were observed.

Observations made in the years 1910, 1911 and 1916 indicated similar dates for pupation.

Therefore it can be said that the larvæ commence their spring feeding as early as the middle of February and as late as the beginning of April, and that the majority begin to feed before March 15, that the period of pupation extends from the middle of April to the third week in May, and that the majority of the larvæ transform before the second week of May.

Unless while moving about, the larvæ contrive to anchor themselves to the plant surface by threads. Notwithstanding the presence of the case they are able to move with considerable agility when they so desire.

Position of Pupæ on Tree. (Pl. 15, fig. 2). On apricot the larvæ spin up chiefly on the leaves, being about equally partial to either surface; and to a much lesser extent on petioles and twigs. On prune and cherries the favorite location chosen is on the upper surface of the leaf at about the middle of the midrib, the case being attached to the rib; but a few individuals settle on petioles and twigs and a very small number dispose themselves on the under surface of the leaves and on the upper surface other than at the favored midrib location. As is the case with the feeding larva, the case projects from the plant surface at a right angle, whereas the cases of the hibernating larvæ often lie parallel to the surface of bark to which they are fastened.

Pupal Stage. The duration of the pupal stage varies with temperature and environment. Normally the pupa case is on the upper side of a leaf and receives much direct sunlight, and pupæ kept in close confinement or in shady quarters develop more slowly than those in natural conditions.

The following table indicates records of the pupal stage in 1910.

TABLE II. PUPAL STAGE, SAN JOSE, CALIFORNIA, 1910

No. Individuals	Date of Pupation	Date of Emergence	Pupal Stage: Days	Av. Mean Temperature
3	May 8	June 1	24	64.2
4	9	1	23	64.4
1	9	2	24	64.8
2	9	3	25	64.2
1	15	16	32	62.8
1	19	16	28	63.4

The average for the 12 individuals was 24.8 days.

Descriptions

Egg. The egg is reddish-brown, .36 mm. to .4 mm. in diameter, and slightly over .2 mm. in height. Its shape is somewhat like an inverted teacup with the rim glued fast to the leaf surface; the central part of the top surface is depressed and forms an outer circular ridge; the sides are strongly ridged.

Larva. The larva is cylindrical, broadest at third abdominal segment, with head and anal segment sub-equal in breadth. The young larva is bright orange, with a suffusion of reddish in the regions of the thorax and penultimate body segment. The head, prothorax, thoracic plates and anal segment are strongly chitinized and appear dark grayish-green. The thinner chitin of the rest of the body appears granulate. The three pairs of prolegs are hyalin. From the heavily chitinized portions issue long thin pale spines and the lightly chitinized portions bear a number of short spines. The longest spines are in length about one quarter the maximum width of the caudal segment. On the lower surface of this segment is a transverse row of from 10 to 22 short hook-shaped bodies. In the mature larva the chitin plates are blackish, as are also the prolegs, while the body color is grayish-yellow. In the older larvæ distributed over the central part of the abdomen are six sets of hooklets similar to those on the ventral surface of the anal segment. These sets consist each of two short parallel rows of from 3 to 9 hooklets. There are two sets on each of abdominal segments 3, 4, 5.

Pupa. Light brown, cylindrical in shape; antennæ reach slightly beyond the caudal extremity; wing-pads reach almost to caudal end; body clothed with sparsely distributed pale hairs. On the dorsum runs a darker median stripe about half the width of the body. Length 5 mm., maximum width about 1.3 mm.

Pupa Case. Black; somewhat roughened; tubular; on the thickened cephalic end are two papery flaps or wings, one on each side; apex curved in the texture of the butt of a pistol. Dissection of the case discloses a hidden slit running the whole length of the ventral surface and continued across the apical surface, by which means the moth emerges. Length about 6.5 mm.; width at cephalic end about 3.2 mm.

Adult Moth. General appearance silvery white; abdomen light brown; antennæ silvery with annulations brown; head and thoracic dorsum with silvery pubescence and hairs; palpi fringed with long hairs, the inner ones white, outer ones brown; eyes black; upper wings white, flecked with light brown spots; lower wings greyish; both wings with fringes of long brownish hairs on hind margins; legs clothed with silvery pubescence, the femora also with long white hairs; under side of body with silvery vestiture; under side of wings dark brown. Length of body about 4.3 mm., length of antennæ about 3.2 mm., length of wings about 6.4 mm. (Plate 15, fig. 3.)

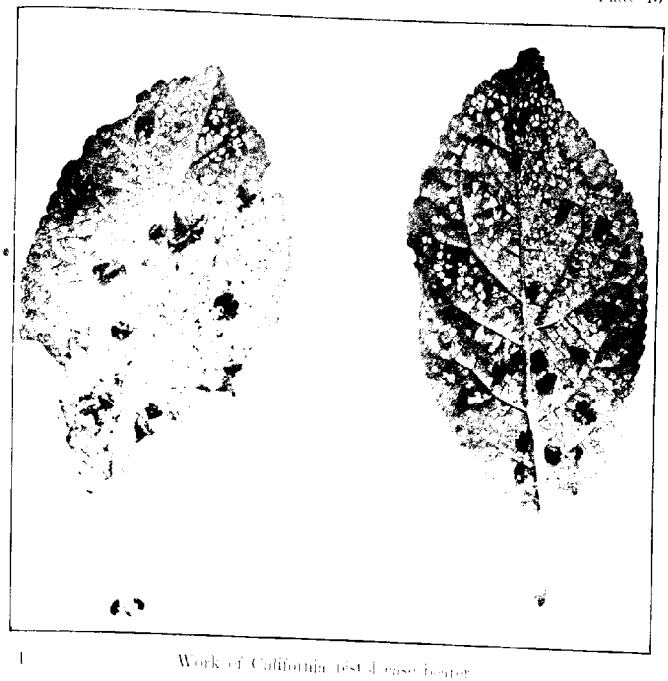
In nature the normal position of the moth is with wings folded over the body and antennæ porrect.

Parasites

The larva is commonly parasitized by a small blackish pteromalid fly, *Eurydinota flavicorpus* Girault.

In 1910, on the dates April 29 and May 2, out of 80 cases examined 7 were parasitized, while on May 14 out of 55 cases examined 23 or 42 per cent were found to be parasitized. This would indicate that the parasitism did not make itself evident until the larva was nearly mature. In 1916 about one-third of the cases collected for the rearing of adults gave parasites instead. There are from 10 to 20 parasites in each case and they make their exit out of a single circular hole at the apex of the case. They issue at the time when the last moths are emerging.

There are no records of predaceous enemies.



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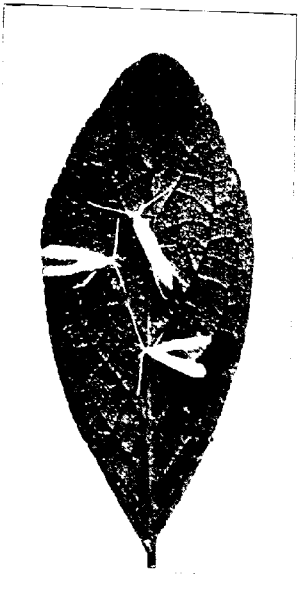

THE LOTUS BORER

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The resemblance of the lotus borer to the recently introduced European cornstalk-borer (*Pyrausta nubilalis* Hübn.) is so close that the two species are apt to be mistaken for each other. It has, therefore, been thought advisable to bring together an account of the former from notes which the writer accumulated some years ago.

When this common pyraustine moth was given its specific name, *Pyrausta penitalis* Grote, a statement was made, from Prof. F. H. Snow, who supplied specimens from Lawrence, Kan., as follows: "Common; feeds upon the 'receptacle' of the Western Water-lily (*Nelumbium luteum*)."

This was in 1876.[1] Since that time the insect has several times come under notice as an enemy of this plant.

Some years ago the writer observed the larva in considerable numbers in raspberry canes. As about 40 per cent of the canes contained larvæ, it was naturally supposed that the species might prove a pest, more especially as we had also received larvæ boring in cornstalks. The result of studies of the insect's habits shows conclusively, however, that the hypothesis that it might do serious injury to other plants than the lotus was unfounded. A number of unrecorded observations, however, have been made, and these, with the Bureau of Entomology notes on the insect's life history, add considerably to our store of knowledge of this species. No extended article on this insect has been published so far as the writer is aware.

DESCRIPTION

The moth is pale yellow, and has been described as pale clear luteous, varying to ferruginous reddish luteous, with all intervening shades. The distinctness of the markings as shown in the accompanying figures (Pl. 16, figs. 1 and 2) has led to the species being described under a synonymical name. In faintly marked individuals the zigzag and other lines of both primary and secondary wings are very faint; in the darkest forms they are strong. The wing expanse is between three-fourths and one and one-tenth of an inch.

The larva when full-grown measures about an inch (25 mm.) in length. It is nearly cylindrical, being slightly depressed. It is marked with dark piliferous tubercles somewhat like the common

[1] Grote, A. R. Can. Entom., May, 1876, pp. 98, 99.

garden webworm (*Loxostege similalis*), as will be seen by reference to pl. 16, fig. 1, *b*, *c*, *d*. It is also of a similar color, which may best be described as dirty gray, with a dull reddish or purplish tinge.

The pupa (*e*) measures about half an inch in length, and just before the issuance of the moth is very dark brown, nearly black, the empty pupal skin being pale yellowish brown.

References to technical descriptions will presently be furnished.

Distribution

The list of localities from which we have received this insect and from which it is already recorded shows general distribution from New Jersey westward to Illinois and Kansas, and southward to Texas. The exact localities known are as follows: Bordentown, N. J.; Washington, D. C.; Urbana and Champaign, Ill.; St. Louis and Kirkwood, Mo.; Lawrence and Onaga, Kan., and Hockley, Tex.

History

This species came under the observation of Dr. C. V. Riley in its larval stage in the year 1876 in galls, evidently lepidopterous, on the so-called slender pink Persicaria, (*Polygonum incarnatum*). Moths from this lot began issuing May 29, continuing to June 6. The locality is not specifically mentioned, but it was undoubtedly St. Louis, Mo., as Dr. Riley was stationed there that year.

We have received larvæ from Miss M. E. Murtfeldt which were found boring in the stems of Eupatorium at Kirkwood, Mo.; also moths from the same source labelled October 9, 1884. In the biological collection of the National Museum is a moth reared from the stems of the wild water pepper (*Polygonum hydropiperoides*).

The first recorded description of the habits of this species is that by D. W. Coquillett in 1880.[1] The larva is there described under the name *Botis penitalis* Grote, with the statements that it "feeds on Indian hemp (*Apocynum cannabinum*)," that it "lives in a nest of leaves which are fastened together with silken threads," and that the species "assumes the chrysalis form in its nest."

An account of this species is also given by C. A. Hart,[2] in which mention is made of the occurrence of the larva in the large receptacles of *Nelumbo lutea*, and of its having been reared from larvæ boring in the stems of *Polygonum incarnatum* near Urbana, Ill. This account is accompanied by technical descriptions of the larva, pupa, cocoon, and imago, with notes on the insect's life habits.

[1] Can. Ent., Vol. XII, p. 45. The description furnished of the larva shows considerable disagreement with what we now know to be *penitalis*, and it is probable that some other species was under observation.

[2] Bul. Ill. State Lab. Nat. History, Vol. IV, pp. 180–183, 1895.

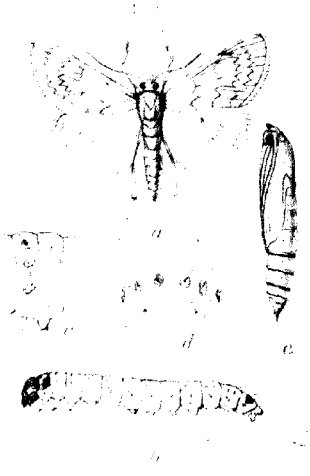


Fig. 1. The lotus borer *Pagaxsta junctalis*: *a*, male moth; *b*, larva, latera view; *c*, abdominal segment with prolog, lateral view; *d*, same, dorsal view; *e*, pupa from side—all enlarged. Original.

Fig. 2. The lotus borer *Pagaxsta junctalis*, female moth. Enlarged, original.

Fig. 3. Section of corn stalk showing perforations made in interior by lotus borer *Pagaxsta junctalis*, also exit hole at left. Original.

In the summer of 1889 Dr. J. B. Smith received specimens from Bordentown, N. J., where the caterpillar was feeding in the flower-stems and leaves, buds, flowers, and seed capsules of the Egyptian lotus. Assuming it to be a new species, a technical article was published on the insect under the caption "A New Species of Botis,"[1] and a popular one entitled "An enemy to the Egyptian Lotus."[2] The former includes a description of the species, as *Botis nelumbialis* n. sp., and of the mature larva. Both articles are illustrated with a figure of the moth, showing two color varieties, and of the larva with details.

August 28, 1890, we received larvæ from Mr. F. W. Thurow, Hockley, Tex., found feeding on the leaves and boring into the stems of *Nelumbium luteum* (= *Nelumbo lutea*).

November 31, 1891, we received from Mr. F. F. Crevecoeur, Onaga, Kan., pieces of the stalk of a late variety of corn (shown in pl. 16, fig. 3) which contained larvæ that were ultimately reared, the moths issuing the year following, March 12 and April 2.

The moths issued from June 4 to 14. One larva transformed to pupa May 16 and to adult June 2, in cool weather, having been in the pupal stage seventeen days. Another pupated June 3 and transformed to adult June 14, having passed eleven days as pupa; weather warm and sultry during the latter period.

As previously stated the finding of this species in abundance in the stems of raspberry led to the impression that the larva was injurious to that plant, and as a consequence a considerable number of specimens and infested canes were gathered for study. That this assumption was natural it will only be necessary to state that sketches were prepared at the time of the receipt of this species and its subsequent rearing in corn, and that the impression was an erroneous one is proved by the fact that there is no evidence that the species feeds on either healthy corn or raspberry, although it feeds on the pith to a considerable extent, but on the contrary develops chiefly upon lotus and other aquatic or semiaquatic plants and enters cornstalks and the cut ends of raspberry canes chiefly as a retreat for passing the winter and for subsequent transformation.

Summary of Life History and Habits

From available sources including the accounts of Smith and Hart, and from analogy, an approximate life history may be summarized as follows:

The species hibernates in the larval stage, the first moths issuing from March until June, according to locality. The eggs and place of

[1] Entomologica Americana, Vol. VI, pp. 88–90, 1890.

[2] Garden and Forest, Feb. 19, 1890, p. 88.

oviposition have not been observed, but the larva when it first appears lives on the outer and upper surface of leaves in a little silken tent-like web, but it soon displays a strong tendency toward what is termed "inside feeding," in perforating and devouring buds and seed capsules and the interior of stems which may be available. During summer it feeds and grows apace until toward the end of August. It then crawls into whatever stems are convenient for the purpose and forms its winter retreat. From one to three or four larvæ sometimes enter a single stem; one is the usual number, although two are frequently found. In stems like those of raspberry the larva makes a burrow wide enough so that it can turn about if necessary, and measuring from an inch and a half to two inches. Both ends are frequently found plugged with small masses of pith, and when more than a single larva inhabits a stem their burrows are separated by a considerable mass. A small amount of silk is used in the construction of these hibernating chambers, and a little is usually to be found at either end. The writer has not seen in raspberry canes anything approaching a true cocoon, but it constructs them in other plants. Some of the hymenopterous parasites form a distinct cocoon.

The observed food plants are Lotus (*Nelumbo lutea*), Polygonum, Apocynum and Eupatorium.

Natural Enemies

Panzeria penitalis Coq. Less than half of the larvæ collected by the writer in the stems of raspberry were reared to the imago, the remainder being parasitized, chiefly by the tachina fly mentioned, which issued June 3 to 20. Washington, D. C.

Zemelucha (*Porizon*) *facialis* Cr. This ichneumonid parasite reared with the above June 3.

Three other tachina flies are recorded as parasites of this insect.[1] They are *Exorista vulgaris* Fall., *Hypostena variabilis* Coq., and *Phorocera comstocki* Will.[2]

Bracon xanthostigmus Cr. was reared at St. Louis, Mo., September 15, 1875.[3] This has also been reared on more than one occasion from blackberry canes, including some that were infested by *Agrilus ruficollis*.[4]

Mention is made in the article by Mr. C. A. Hart[5] of a braconid

[1] Technical Series No. 7, of this Bureau, p. 27.

[2] The first and last of these three tachinids were mentioned by Prof. C. H. T. Townsend (Psyche, Vol. VI, June, 1893) as having been reared from this pyralid by Dr. S. A. Forbes, Champaign, Ill.

[3] Insect Life, Vol. II, p. 349.

[4] L. c., Vol. IV, p. 257.

[5] L. c., p. 181.

and a chalcidid parasite of this species, the latter being secondary on the former.

In addition to the parasites which destroy this species, blackbirds are said to eat the larvæ before they go into shelter.

Control

A spray of arsenate of lead, Paris green or other arsenical could be used in the destruction of the young larvæ before they penetrate the interior of buds, seed capsules, stems, and the like. Where they are found at work in these shelters, however, about the only recourse would be to pick the affected portions by hand and burn them. The collection and destruction, also by burning, of the stalks in which the insects are found late in the season, is also advisable. In the occurrence of the insect on Lotus all parts of the plant containing the insect above the water line should be cut away as soon as this can be conveniently done.

ANASTREPHA FRATERCULUS WIED. (TRYPETIDAE)—A SEVERE MENACE TO THE SOUTHERN UNITED STATES

By E. W. Rust, *Entomologist of the Tucumán Experiment Station, Tucumán, Argentina*

In almost all tropic or sub-tropic lands fruit-growing is subject to severe losses occasioned by insect pests, and among the latter one of the most damaging is almost sure to be some one of the fruit-flies of the family *Trypetidæ*.

In the northern part of the Argentine Republic, where the writer is stationed, the particular scourge of the fruit-grower is *Anastrepha fraterculus* Wied., and during the past two years it has been the subject of more or less constant observation. During that time we have noted with surprise that so little is known, and even less published, about an insect which is such a menace to the fruit-growing interests of the semi-tropic portions of the United States. The Mediterranean fruit-fly is known by name and dreaded by a great number of fruit- and vegetable-growers, thanks to the wide-spread publication of the most excellent work done by the United States Bureau of Entomology. The melon fly (*Bactrocera cucurbita*) and the Mexican fruit-fly (*Anastrepha ludens* Loew) have also come in for some share of popular attention, but it appears that comparatively few people realize what a scourge *Anastrepha fraterculus* might become if once it gained entrance to the Southern portion of the United States.

Distribution

Anastrepha fraterculus might well be called the South American fruit-fly, as it is indigenous to, and well distributed over the warmer portions of South and Central America, and the West Indies, where it is regarded as only less destructive than the Mediterranean fruit-fly. Moreover, it occurs as an extremely destructive agent in many sections where the latter has not as yet gained entrance. So far, we have authentic records of its occurrence in Brazil, Argentina, Peru, Colombia, Yucatan (Mexico), Cuba and Porto Rico. Beyond a doubt it is found in most of the other islands of the West Indies, but has not been definitively reported as yet. Northern Chile, Ecuador and the various Central American States will doubtless be added to the list also, as soon as anyone is in a position to search these regions, as it seems certain that this fly has penetrated to all the warmer portions of South and Central America where fruit is grown. In some sections it is as yet only a menace, while in others it has assumed almost the proportions of a calamity.

Damage Done

In the Province of Tucumán (Northern Argentina) *Anastrepha fraterculus* is variously known as "la mosca de la fruta" (the fruit-fly), "el gusano de la fruta" (the fruit-worm), "la mosca del naranjo" (the orange fly), and "el gusano del naranjo" (the orange worm). It is definitively known to have been present at least twenty years, and in conversation with old residents, the writer has learned that as long ago as the natives can remember, thin-skinned fruits, such as peaches and chirimoyas, have been regularly destroyed by a maggot, which is described as identical to that found in all kinds of fruits today. After a thorough canvass of the situation, there seems little reason to doubt that the fly is indigenous to this section, or has at least been present for several decades.

During this period it had been noted that the pest caused more damage during certain years than others, and this fact was attributed to combinations of climatic factors not completely understood. However, it appeared certain that the maximum amount of sound fruit was obtained following seasons during which climatic extremes of one kind or another had occurred. But even after such periods unfavorable to the fly a large percentage of the local peaches and apricots were apt to be wormy; in bad years practically all soft or thin-skinned fruits were destroyed, and in recent years even the various species of citrus have been, in their turn, badly infested. This latter condition is, however, of only recent date, for it is only within the last three or four years that any infestation of citrus fruits has been noticed; but during

this period the condition has become more and more wide-spread and the percentage of infested oranges has increased until during the autumn of the present year (March–April and May, 1918) a loss was experienced of nearly 50 per cent. of the oranges in some sections; and one grower reports the dropping of at least three-fourths of his crop of pomelos through the agency of this insect.

Conditions at present are worst in the Province of Tucumán, and it is in the central and southern portions of this province only that oranges are severely damaged. On the other hand, almost all thin-skinned fruits are more or less subject to infestation in most parts of Northern Argentina. In the Province of Salta and the majority of the Province of Jujuy peaches and apricots are generally almost a total loss, due to the rot engendered by these maggots, and chirimoyas or "custard apples," plums, etc., are regarded with suspicion until after a thorough examination. Although very excellent oranges have been produced in that section (notably at Orán, Salta) for more than one hundred years, the fruit-fly does not seem to have adapted itself to that host to any great extent, as yet, in the two provinces named, but indications point to a heavier infestation in the future. The writer saw evidences of oviposition in nearly every orchard visited in those provinces during May of the present year, and ventures that before the lapse of many years even the wild oranges in the forests around Orán will be the regular hosts of this fruit-fly, which seems to be gradually extending its ravages to fruits heretofore considered immune. Conditions which will bring about a serious infestation of these oranges will be a season when many flies have emerged, followed by a sudden diminishing in the usual quantity of thin-skinned fruits of late summer or autumn, which will force large numbers of flies to oviposit in the oranges.

Description of the Fly

The adult of the maggot which makes all this havoc might be said to resemble, in a general way, the common house-fly, except that the former is yellowish-brown in color and of somewhat larger size. In this matter of size, some latitude should be allowed, for individuals of both sexes vary greatly in this particular, in accordance with the conditions under which they developed. The writer has seen a statement to the effect that the female measured about 12 mm. in length (exclusive of the ovipositor) by slightly more than 25 mm. across the extended wings. The foregoing is, however, a trifle large, as an average, for the flies which occur in the region under discussion. Data obtained from the examination of large series of individuals show the following characters:

Length of average female (exclusive of ovipositor), 8 to 9 mm.; length of ovipositor, 2 mm.; wing expanse, 18 to 20 mm. Length of average male, 7 to 8 mm.; wing expanse, 15 to 16 mm. Eyes conspicuous, of living or recently killed specimens, beautifully irridescent but gradually turning dark brown to blackish. Body yellowish-brown to almost castaneous, except ventral side of thorax which is very light brown to straw-colored; thorax with three sulphur colored, longitudinal stripes on dorsum and another on each side reaching from wing base to head; scutellum sulphur-yellow, abdominal segments edged with light yellow, giving appearance of three well-defined transverse stripes. Wings comparatively large and relatively more slender than those of *Ceratitis;* hyaline, stained in places with a distinctive pattern of yellowish-brown which involves the base of the wing and extends (with one slight interruption) in a broad stripe along the anterior margin to the tip; the interruption alluded to leaving a small notch-like, clear spot near the center of the anterior wing-margin, and from the lower angle of this spot another band curves downward and backward to the basal angle of the wing; on the distal half of the wing is another streak, like an inverted V, one prolonged arm of which rests upon the posterior wing-margin, while the apex almost (and in certain cases, quite) joins the aforementioned stripe along the anterior margin, at a point just distad of the clear spot. Wings irridescent in certain lights. In freshly emerged individuals the eyes are unusually conspicuous and flash combinations of red and blue which vary with the light. Newly emerged flies are wholly straw-colored, with nearly clear wings, but the body soon darkens and the characteristic patterns on both body and wings soon become well-defined. The wing pattern does not seem to be absolutely constant, and some slight variations, both of shade and pattern, are often noted. Female ovipositor brown, tipped with black hairs, stout, mainly cylindrical but slightly flattened on the under side, tapering uniformly to the tip.

Oviposition

When a female fly is ready to deposit eggs, her first care is to find a suitable host in which to place them. Various kinds of fruits serve for this purpose and they are attacked in various stages of maturity, according to the fruit chosen and the season of the year when oviposition takes place. When the female fly alights upon a fruit, she first explores the surface, all the time gently waving her wings in the manner characteristic of these insects. Then when a seemingly satisfactory point is found, she stops and bends the ovipositor at right angles to the body, the abdomen remaining in the customary horizontal position and the ovipositor being bent at the point where it joins the abdomen. In this position the tip of the ovipositor just touches the surface of the fruit. Then the stylets are exerted and introduced into the rind. As they enter, the fly sways slightly backward, so that the ovipositor forms an acute angle (about 50 per cent.) with the body, in which position she remains during the major portion of the time occupied in oviposition, which varies from a trifle over thirty seconds to about a minute and a half. Then ensues a period of rest and exploration of from two to three minutes, before another puncture is made. The eggs are elongated, somewhat spindle shaped, whitish in color

and about 1 mm. in length. They are sometimes placed singly but often several occupy the same cavity and a single fruit may be oviposited in many times by the same or by different insects; thus it may happen that a fruit bears the marks of the ovipositors of so many females as to almost cover its surface with scars.

The Larvæ

The eggs hatch, commonly in from two to four days, into minute white larvæ, which immediately start eating their way through the fruit. These larvæ are of the usual maggot type, slenderly pointed at the forward end and terminating bluntly at the opposite extreme. As they grow they also darken in color until when three-fourths grown they are creamy white, after which they become creamy, to yellow, and finally attain a length of from 7 to 9 mm. or even 10 mm. In summer the larval period averages from twelve to fifteen days, which may be prolonged to several weeks by the cold of winter.

The Pupæ

Upon becoming full grown the larvæ leave the fruit and burrow several centimetres into the soil, there to form the pupa, which is of the usual castaneous, capsule-like type. Or the pupa may be formed under the first convenient object, or even in an exposed position if the larva cannot bury itself. The pupal period also varies greatly, ranging from twelve days to several weeks, according to temperature.

The Adult

Upon emerging from the pupa, the adult fly is very soft and can easily make its way through the small cracks and interstices of the soil until it reaches freedom at the surface. There its body hardens and the wings expand until it is able to fly in search of the fruit juices, sap or honey-dew upon which the adult normally feeds.

In confinement the flies die within three or four days, unless supplied with food, but if syrup or juicy fruit is supplied them, they may live for astonishing lengths of time. Without any special attention, the writer has kept flies alive for more than three months and has no idea but that this period may be greatly prolonged under more favorable conditions. In this connection, it was noted that the males generally died first, just as they often are first in emerging from the pupa.

Fertilization of the female often takes place during the first day after emergence, and eggs have been secured upon the third day, but generally oviposition begins upon the seventh or eighth day after emergence and may continue for a long period. The maximum length of time during which a female may deposit eggs has not yet been deter-

mined, nor has the maximum number of eggs laid per day, but as several eggs seems the normal rate per day during a prolonged period, it seems reasonable to calculate that the average female *Anastrepha fraterculus* is capable of depositing between 500 and 800 eggs during her lifetime.

Host Fruits of A. fraterculus

The eggs are deposited in, and the resulting larvæ more or less completely destroy the following fruits, according to a recent list published by the United States Federal Horticultural Board.:[1]

Guava (*Psidium guajava*), coffee berries, pear, peach, mango, orange, *Eugenia* spp. *Phylocalyx*, Japanese plum, Japanese persimmon, Pará plum, (*Spondias* spp?) *Anona humboldtiana*, jobo amarillo, jobo de la India.

To the foregoing can be added the following fruits which the writer knows to be infested in Northern Argentina: strawberry guava (*Psidium* [*Campomanesia*] *cattleyanum*), Chinese guava (*Psidium* [*Campomanesia*] *lucidium*), fig (*Ficus carica*), pomelo (*Citrus decumana*), kumquat (*Citrus japonica*), tangerine (*Citrus nobilis*), apricot (*Prunus armeniaca*), avocado (*Persea americana*), chirimoya (*Anona cherimola*). In addition it may be stated that the fruits of *Feijoa selowiana* have been reported as infested at times, and that in several instances the writer has found lemons (*Citrus medica limonum*) which showed evidence of having been "stung" by the fly, although no larvæ have so far been found in the last named fruit.

Methods of Attack in Different Types of Fruit

In the region under discussion the first fruits to be attacked in the spring are probably the apricots, which are soon followed by peaches, and it is the latter fruit which may be regarded as the principal summer host of the insect. Adult females which have successfully passed the colder months or which have emerged from over-wintering larvæ or pupæ, become active early in spring and place eggs in early apricots where the larvæ develop at a comparatively rapid rate. These larvæ give rise to a large number of flies which are ready and waiting for the early peaches, and in the haste to deposit eggs some fruits are "stung" while yet not much more than half-grown, but in these the larvæ are not able to develop. Such peaches may drop or may cling to the tree, but in any case they "mummify" and do not become soft with rot, which latter condition seems to be more or less essential to the success-

[1] A Manual of Dangerous Insects Likely to be Introduced in the United States Through Importations. Edited by W. Dwight Pierce. Washington, D. C., Aug. 15, 1917.

ful development of the larvæ. The most propitious time for oviposition in peaches seems to be two or three weeks before the fruit would normally ripen. At this time they are still firm and green, but the pulp loses its excessively hard, dry, astringent qualities and becomes sweet enough and moist enough to nourish the young larvæ. These now develop very rapidly and eat out a large part of the flesh and cause the rest to rot so that the larvæ are nearly always enveloped in a decaying mass which seems exactly to answer their requirements. At this stage the fruit colors up and may appear normal except for a few small holes which the worms make in order to obtain air, but it is soft to the touch, and when opened presents a disgusting mass of corruption, filled with from three or four to thirty or more wriggling, whitish maggots. This decay causes a premature ripening of the unattacked flesh and the whole fruit falls to the ground at a time when sound fruits of equal age have as yet scarcely begun to ripen. If it still contains undeveloped maggots, these are generally able to finish their development in the fruit upon the ground.

Under the favorable conditions of abundant food and suitable temperature which obtain at this season, the egg period is passed in two days, larvæ develop in another seven to ten days; and the pupal period is passed in twelve to fifteen days more, so that we may have adults from eggs deposited only three weeks before. This, however, is the minimum, attained only under the most favorable conditions, and the normal time from one generation to another is very close to thirty days in summer.

By the end of the peach season, the flies have reached their maximum number and there is scarcely enough fruit for all to place their eggs in during years of heavy infestation, so almost any kind of fruit is used for oviposition, but only in certain kinds do the maggots succeed in developing. After the peaches have all been destroyed, the females turn their attention to later fruits, such as chirimoyas and guavas, each of which serve as host for one or more generations of the insect. Fruits then become somewhat scarce and not much is left except persimmons, which to some extent engage the attention of such females as are bent on oviposition. Thus pass the summer months of December, January and February and oranges will soon be in a condition to attack. Meanwhile the females content themselves with eating, sunning themselves in warm nooks, or keeping in the shade at mid-day, and waiting. They can pass long periods without depositing eggs and yet be in perfect condition to resume this function as soon as an opportunity is presented, so their numbers do not diminish to any very great extent during a short scarcity of fruit. By the end of February or the beginning of March oviposition begins in oranges but the fruit is gen-

erally too green and very few if any of the first maggots develop, even if the eggs hatch. But from the middle of March to the last of April, or even longer during favorable weather, larvæ regularly develop in many of the oranges of this section. Especially is this true in thin-skinned varieties or those with a loose peel such as the tangerines have.

Eggs are often deposited in large numbers in oranges, but no larvæ develop. This was very puzzling at first but it has since been found that during oviposition some of the oil cells, so numerous in citrus fruits, are often ruptured and the strong essential oil thus liberated destroys the eggs. But even if this accident is escaped, not all danger is passed, for if the eggs be deposited in very thick-skinned fruits such as bitter oranges, pomelos, or even some seedling oranges, the larvæ are very apt to starve to death before they can penetrate the innutritious rind and arrive at the pulp on which alone they can thrive.

Another puzzling question was why the fruit so often dropped when no signs of larvæ could be found in them. After extensive experiments it was proven to the writer's satisfaction that even if no eggs were deposited by the female at the time oviposition was attempted, yet the resulting punctures were often sufficient to allow the fruits to become infested with *Colletotrichum* and other fungus spores or by bacterial rots which caused a premature ripening and fall of the fruit, and it is probable that the ovipositor of the female really acts as the vehicle of infection in many cases. Especially was it noted that pomelos are almost sure to develop typical *Colletotrichum* spots after being "stung" by the fly, and it is due to the fungus and not to the fly larvæ that they drop prematurely, for the fly larvæ rarely reach maturity by tunneling the thick rind of this fruit. The eggs may hatch and the young maggots may feed for awhile but they generally die before pupating.

The growth of *A. fraterculus* larvæ in citrus fruits is slower than in the other fruits mentioned, and this may be due partly to the qualities of the fruits themselves, but is more apt to be the effect of the lower temperature which always occurs during the autumn and winter, when the citrus fruits are ripening. During the first part of the season larvæ developed in the orange in from twenty to thirty days and then remain in the pupal stage from fifteen to twenty-five days longer (according to temperature) or a matter of from thirty-five to fifty-five days for the immature stages, but as the weather grows colder development becomes slower until finally it stops completely and the coldest season is spent in a quiescent state by both larvæ and pupæ, but the adult continues actively feeding during warm days even if the temperature has dropped as low as freezing the previous night. Thus we have *A. fraterculus* passing the coldest months of July and August as larvæ in citrus fruits, as pupæ protected by the soil, and as adults, which have

been seen to survive temperatures as low as −7° C. By means of this resistance to unfavorable conditions all stages are able to withstand the cool weather and resume their normal activities with the more favorable weather of early spring, when a new swarm, composed of both over-wintering females and those freshly emerged, is ready to attack the early apricots, thus completing the yearly cycle.

Climatic Conditions

Climatic conditions seem to be the decisive factor as to whether this insect will be severely destructive or only moderately so. If conditions have been favorable to a heavy crop of fruit, a good proportion of the same may, during the first part of the season, be free from attack, but from this very abundance of food results such a great and rapid increase of flies that the fruit maturing during the remainder of the season is apt to be very largely infested. Thus, a big peach crop gives rise to a swarm of fruit-flies which multiply rapidly in the many successive and suitable summer fruits, until oranges are sufficiently developed for oviposition in the autumn. These, being practically the only fruit left, receive the full attention of almost all the flies and a heavy infestation results. On the other hand, unfavorable weather conditions tend to check the increase of the fruit-fly, but sometimes they also result in curtailing the fruit crop as well, so that things are pretty evenly balanced and nearly all the fruit is again infested. However, if the unfavorable weather occurs early enough in the season, the flies may be severely checked without doing much damage to fruit-trees which have not bloomed as yet, and a good crop of comparatively clean fruit results.

Now, what climatic conditions may bring about these results? Naturally one thinks of cold. But a cold spell of sufficient duration and intensity is seldom encountered in the semi-tropics. Nor is it a condition to be desired from other points of view. During the present winter this locality has suffered from temperatures of from 0° C. to −7° C., followed by warm sunshine, and at mid-day many specimens of *A. fraterculus* were observed as active as ever. Thus it appears that even a killing frost does not have much effect on the adults, and even less on larvæ in oranges or upon pupæ which may be safely protected in the soil.

As to humidity. Where rains occur in the hot season, as here in Northern Argentina, they only stimulate plant growth and tend toward increasing the food supply of the flies and to the rapid development of the latter in all their stages. In fact it has been noted repeatedly that during and after a rainy season, damage by the fruit-fly is generally more severe.

Conditions due to altitude cannot be thoroughly discussed until more data are collected, but it appears likely that this is not an important factor, from a practical view-point, if other conditions are favorable, as the fly has been collected by the writer at various elevations, ranging from 1,000 feet to nearly 4,000 feet. In other and more tropical regions it has been collected at slightly above sea level, so it appears safe to venture that this insect is capable of making itself very obnoxious at any altitude up to at least 4,000 feet, if conditions of temperature, etc., are favorable.

There remain to be discussed, heat and drouth. These two factors often occur together, and when they are severe are certainly a great check to the fruit-fly. Either condition alone may greatly curtail the insect's food by causing fruit-trees to bloom but scantily or by causing fruit to drop after it has been formed. When both heat and drouth are severe (and especially if prolonged) fruit is certain to be very scarce and the fly is consequently checked in its multiplication, in which case the fruit of the succeeding season will be comparatively free from maggots. Not only do the above conditions cause a scarcity of the flies' food, but many larvæ and pupæ are killed outright and the adults are greatly restricted as to the time during which they can oviposit. With a temperature much over 100° F., larvæ are often literally cooked in the fruit which fall in the sun, before they can escape and enter the soil; and even if they do succeed in burying themselves, such excessive temperatures as were experienced in Tucumán during the summer of 1917[1] were enough to bake them everywhere the sun reached. Such a temperature is also fatal to emerging flies, and even the mature adults refuse to oviposit during the hotter parts of the day, but remain motionless on the underside of leaves, or upon the ground in the shade. It has been noticed that after a prolonged hot, dry period, *A. fraterculus* is much less numerous than usual and that unless very favorable conditions for its rapid increase occur during the succeeding winter, spring or early summer, the fruit of these seasons will be comparatively free from attack by the larvæ. However, by the end of summer they have generally become numerous enough to again be conspicuous and to do a large amount of damage during the succeeding year, unless something happens to give them another check.

Parasites

This check to their multiplication may be either natural or artificial, and in addition to causes of the former kind discussed above, may be mentioned parasites. However, these are, as yet, very little known.

[1] January 20, 1917. Maximum at the Experiment Station, 114° F. in the shade. Maximum in the city of Tucumán, 118.5° F. in the shade.

In rearing thousands of specimens of *A. fraterculus* from all sorts of fruit hosts, only a very small number of parasites have thus far been encountered and these were all a certain *Ichneumonid* as yet undetermined. It has been reported that other parasites attack *A. fraterculus* in Brazil, but the writer has no authoritative information as to how effective a check they really are. Doubtless some of the parasites of *Ceratitis capitata* could be used to good advantage against our South American fruit-fly, but the opportunity for giving them a trial has not yet presented itself.

Artificial Control

As is often the case with other species of fruit-flies, artificial control of any kind has not yet proven very successful against *A. fraterculus*. Such measures have been recommended as the destruction of infested fruit, the capture and destruction of adult flies, poisoned sprays, etc., but conditions here, as elsewhere, prevent such measures from being effective. People in general are too careless or indifferent to the clean cultural measures recommended and very little can be done at general control until every individual is willing to shoulder his portion of the responsibility. Poisoned sprays give some promise of being useful under certain conditions and will be given a more extensive trial during the coming year.

THE LIFE HISTORY AND EARLY STAGES OF CALOPHYA NIGRIPENNIS RILEY

By Harry B. Weiss and Alan S. Nicolay, *New Brunswick, N. J.*

According to E. A. Schwarz in his paper "Notes on North American Psyllidæ" (Proc. Ent. Soc. Wash., Vol. VI, p. 234) the development of this species was carefully studied by Mr. Theo. Pergande many years ago and some fine drawings illustrating the various stages were made by Dr. Marx. However the manuscript and some of the drawings could not be found after the death of Dr. C. V. Riley. The drawings, of the first and second larval stages, which accompany this paper were copied from those by Dr. Marx, which appeared in Mr. Schwarz's paper.

The species appears to live exclusively on *Rhus copallinum* L., and ranges according to Van Duzee (Check List of the Hemiptera of America, North of Mexico) from Connecticut southward to Georgia and Florida. In New Jersey we have found *Calophya nigripennis* to be fairly common although it does not by any means occur every place where its food plant grows. According to Stone (N. J. State Mus. Rept., 1910) *Rhus copallinum* L. is found frequently in sandy soil

throughout the northern, middle and coast districts of New Jersey and occasionally in the pine barrens where it is introduced. In several localities we found plants which were heavily infested by the insects, but hardly any noticeable injury was observed. In a few cases, a slight discoloration of the foliage was noted together with some disfiguration of the upper leaf surfaces due to the numerous third stage nymphs which had collected there.

Adults appear about the middle of May in the southern part of the State and about a week later northward and can be found in diminishing numbers up to about the first week of July. For the vicinity of Washington, D. C., McAtee (Ent. News, Vol. XXIX, p. 222) states that they are abundant from May 4 to June 29. After copulation, egg laying takes place, the foliage on the tips of the twigs usually being selected for this purpose.

The eggs are light, lemon yellow when first laid and later become brownish or brownish black. They are fastened singly to the leaf by means of a short peduncle which is inserted in the tissue. The edges of young leaves are favorite places for egg deposition, from two to forty eggs being found on a single small leaflet. The edge of the winged blade of the stem of the compound leaf is also a favorite place for the eggs and in some instances, eggs were found on the upper and lower leaf surfaces, usually close to or on the midrib. The incubation period is from two to three weeks, the first stage nymphs appearing about the middle or last part of June. The insect passes through four nymphal stages, each one of the first three requiring about a month to mature.

By the middle and last week of September practically all of the nymphs are in the third and fourth stages and have sought hibernation quarters on the woody stems. The first two nymphal stages can be found as a rule on the under sides of the leaflets and blades of the stem, many of them feeding with their heads close to the midribs.

After reaching the third stage they appear to migrate to the upper sides of the leaves and especially the upper sides of the blade-like extensions of the stem, where they rest with their heads close to the stem. Most of the fourth stage nymphs and many of the third stage are found on the hairy twigs of the plant, close to the lenticels or crowded as far as possible under the buds in which places they hibernate during the winter. This method of hibernation was noted by Schwarz.

Individuals of the first two nymphal stages are very flat and light yellowish in color. Those of the third and fourth stages are convex, dark in color and covered with globular tubercles of varying sizes arranged in a symmetrical pattern. The color of the last two stages resembles closely the bark of the twigs on which they hibernate. All

of the nymphal stages are fringed with waxy threads, which break readily. These threads are not as long as those with which the nymphs of *Trioza tripuncata* are clothed, but nevertheless are plainly visible. During the process of clearing the specimens the wax threads are lost and only the bases remain, which appear as short spines. In the illustration accompanying this paper, the drawings were undoubtedly made from cleared specimens.

It is thus seen that there is only one generation each year and that development is very slow. This slow nymphal development is characteristic also of the bramble flea louse, *Trioza tripunctata*, for this latitude as noted by Smith (Rept. Ent. Dept., N. J. Agric. Coll. Exp. Sta., 1911, p. 418). In striking contrast to this is the development of the pear psylla, *Psylla pyricola*, in New York which is four brooded during a season, one month being required for a complete life cycle (Slingerland & Crosby, Manual of Fruit Insects, p. 219).

Egg: Length 0.19 mm. Width 0.06 mm. Elliptical, both ends rounded. Chorion apparently smooth, shining black or brownish before hatching; slightly flattened where it rests against leaf. Whitish slender peduncle almost as long as the width of the egg arises usually at a slight angle from a point about one-fourth of the length of the egg from one end.

First Stage Nymph: Length 0.22 mm. Width 0.15 mm. Shape oval, rounded anteriorly and posteriorly, body flat, widest across mesothorax. Color lemon yellow,

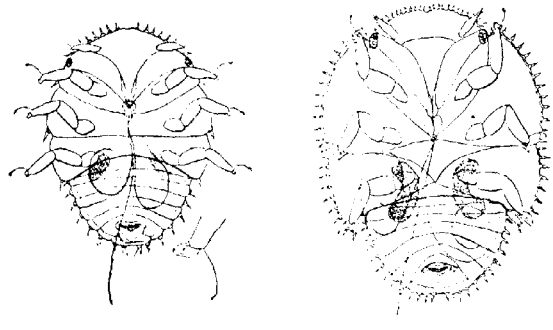


Figure 16. *Calophya nigripennis*, first and second nymphal stages (after Marx).

central portion slightly greenish. Body segmentation indistinct. Antennæ cylindrical, tapering to distal end which is truncate and bears a comparatively long spine-like hair. ♀ Eyes red, on lateral margins of head; head triangular. A fringe of minute spines on anterior margin of head. A minute spine on posterior lateral angle of each thoracic segment. A single spine on the lateral margin of each abdominal segment. All spines in this and later stages rest on minute tuberculate bases and terminate in wax-like hairs. Legs stout, cylindrical, tapering toward tip, apical end

bearing sucker disc and comparatively long spine-like hair. Basal sheath of rostrum extending to between bases of first and second pair of legs.

Second Stage Nymph: Length 0.35 mm. Width 0.35 mm. Shape suboval, widest across mesothorax, narrowest across abdomen, rounded anteriorly and posteriorly, sides of meso- and metathorax arcuate and extended laterally. Color, antennæ and eyes somewhat similar to those of preceding stage. A fringe of minute spines on anterior margin of head, on lateral margins of meso- and metathorax and a pair of spines on the lateral margin of each abdominal segment. Legs somewhat similar to those of preceding stage.

Third Stage Nymph: Length 0.5 mm. Width 0.49 mm. Shape subcircular, anterior end truncate, posterior end rounded; dorsal surface convex; body broadest across thorax and narrowest across abdomen. Color light yellowish to dirty brown, some individuals being additionally marked with black spots. Body segmentation distinct. Antennæ cylindrical, tapering to truncate distal end which is dark and bears two spine-like hairs. Eyes distinct, red. Wing pads more pronounced and extended laterally. Lateral and frontal spines similar to those of preceding stage but more pronounced. An irregular, transverse dorsal row of yellowish or white tubercles on anterior portion of triangular head, a median, dorsal, double row extending from the transverse row to the end of the abdomen. On either side of the median, double row is a somewhat arcuate row starting at the end of the transverse row on the head and extending into the abdomen but not as far as the median, double row. Between these rows are smaller scattered tubercles. Largest tubercles are found on head and thorax. Ventral surface and most of legs light. Distal ends of legs dark, bearing pulvilli, a pair of claws and a spine-like hair. Basal sheath of rostrum extending to between the bases of the second pair of legs.

Fourth Stage Nymph: Length 0.7 mm. Width 0.78 mm. Shape, subcircular, anterior end truncate, rounded posteriorly. Dorsal surface convex; body broadest across thorax, narrowest across abdomen. Color varies from light brown to black, some individuals being spotted with black. The color of the tubercles varies from yellowish to white. Body segmentation distinct. Antennæ similar to those of preceding stage. Eyes distinct, red. Sides of mesothorax extended laterally and anteriorly to anterior margin of head; sides of metathorax extended laterally and posteriorly to almost the middle of the abdomen. Entire periphery of body fringed with waxy threads which break off leaving spine like processes. Entire dorsal surface covered with various sized tubercles, with the following most prominent: transverse irregular row on head just behind the eyes, a median, dorsal, double row extending from transverse row through abdomen, a curved row on either side of median double row and extending from the end of the transverse row on the head to the anterior part of the abdomen. In some specimens there were two curved rows on either side of the median double row. These curved lateral rows are not as prominent in this stage as in the third stage, due to the numerous other tubercles which are present. The entire dorsal surface has a pebbled appearance. Ventral surface and legs similar to those of preceding stage but darker. Legs bearing a few scattered spines. Basal sheath of rostrum similar to that of preceding stage

Adult: Calophya nigripennis Riley, 1884 *rhois* Glover, 1877. Crawford in his monograph (U. S. N. M. Bull 85) gives the following redescription. "Length of body 1.7 mm; length of forewing 2.1; width of head 0.72. Color of vertex, wings, and anterior and middle femora black to brown, wings sometimes light brown; abdomen light brown to almost black; genal cones and thorax bright orange or sulfur-yellow; antennæ, except at tip, posterior femora and all tibiæ pale yellow. Vertex smooth, seldom slightly areolate, shining, very convexly rounded downward in front, more so than

in the other species of the genus. Genal cones small, not as long as basal width, often distinctly shorter, acute at apex, divergent, subhorizontal, not pubescent, contiguous at base. Antennæ shorter than width of head, thick, always black at tip. Thorax smooth, less strongly arched than in preceding species, sometimes faintly alutaceous, sometimes striped on dorsum. Forewings thick, not transparent, somewhat punctulate, narrowly rounded at apex, about two and a half times as long as broad, pterostigma long and large; first marginal cell about twice as large as second. Hind wing somewhat fumate. Genitalia—male genitalia similar to *flavida;* anal valve broad, about two-thirds as broad as long, convex on both hind and front margins; forceps as in *flavida.* Female—genital segment scarcely as long as two preceding ventral sclerites, stout, not acuminate."

THREE SPECIES OF ANASA INJURIOUS IN THE NORTH (HEMIPTERA, COREIDÆ)

By H. M. Parshley, *Smith College*

The common squash-bug, *Anasa tristis* De Geer, was until recently the only species of the genus known to occur in New England. In 1914 C. W. Johnson reported[1] the occurrence of *A. repetita* Heidemann in Massachusetts, and up to the time of publication of my New England list[2] only two additional records came to light. Subsequently I called attention to the discovery of the species in large numbers on the star-cucumber, which would appear to be its natural food plant in this region.[3] Last June I noted *repetita* feeding on young plants of the cultivated cucumber in numbers probably sufficient to have caused some injury, if hand picking had not been employed as a preventive measure.

The case is similar with *A. armigera* Say, long known as injurious in States farther south. In 1914 I met with the first known New England example while sweeping underbrush in a woodland near Boston and took another in the same spot the following year.[4] In the New England list is noticed but one additional capture, at Amherst. I have since taken *armigera* in moderate numbers, feeding on the star-cucumber, and early in the present summer I found it attacking the cultivated cucumber in company with *repetita.* The late generation, consisting entirely of *armigera,* appeared about the middle of August on the cultivated cucumber in such numbers as to destroy some of the plants. From a single vine sixty specimens were collected.

Thus it appears that *repetita* and *armigera* are increasing in numbers in this region, with the likelihood that they will become seriously in-

[1] Psyche, Vol. 21, 1914, p. 82.

[2] Occas. Papers, 7, Boston Soc. Nat. Hist., Fauna of N. E. 11, Hem. Het., 1917.

[3] Psyche, Vol. 25, 1918, p. 64.

[4] Ent. News, Vol. 27, 1916, p. 106.

jurious to cucurbitaceous vegetables; possibly as important in this respect as *tristis*. Present knowledge indicates that the cucumber is preferred, as neighboring squash vines have so far escaped attack. The familiar measures employed in the control of *tristis* are indicated in the case of the other two species, and in addition I would suggest the eradication of the star-cucumber (*Sicyos angulatus* Linn.), as a measure of precaution.

As it will be of interest to have further precise observations on the activities of these potentially destructive species of *Anasa*, I append a table for their discrimination, with the data of their occurrence in New England.

1. Head with two long slender spines projecting forward; color brown, connexivum very distinctly banded, terminal antennal segment pale; length 11–14 mm. *armigera*

   Head without prominent spines projecting forward 2

2. Head with a small tubercle just behind the base of each antenna; color light to dark brown, with coarse black punctation, lateral margins of pronotum pale, connexivum indistinctly banded; terminal antennal segment dark; length 14–17 mm. ..... *tristis*

   Head without such tubercles; color light yellowish-brown, lateral margins of pronotum concolorous, connexivum distinctly banded, terminal antennal segment pale orange yellow; length 12–15 mm. ..... *repetita*

A. tristis De Geer. The squash-bug. Throughout New England; 11 May to 16 October.

A. repetita Heidemann. The cucumber-bug.

Massachusetts—Allston, Amherst, Beach Bluff, Boston, Northampton; 13 June to 24 September.

Connecticut—Wallingford.

A. armigera Say. The horned squash-bug.

Massachusetts—Amherst, Boston, Northampton; 4 June to 24 September.

NOTES FROM TASMANIA

By Frank M. Littler, *Launceston, Tasmania*

Currant Clearwing Moth. The currant clearwing moth (*Aegeria* [*Sesia*] *tipuliformis* Clerck) has been noticeably on the increase on red, white, and black currant bushes in various parts of Tasmania during the past few years. So far as is known it has not as yet appeared in the southern half of the island. The insect as a pest has been known to the writer for the past ten years. Neither raspberries, nor gooseberries yet appear to be affected. The perfect insect makes its appearance during November, and odd ones may be captured up to early January. By May the larvæ are nearly full grown, and from then until early spring they remain practically quiescent. The length

of the pupal stage has yet to be determined; it will doubtless be found to approximate that in other countries. The eggs appear to be always laid close to a bud or shoot. During last summer the writer was successful in discovering a parasite in the shape of an Ichneumon very close to the Tribe Rhyssides. The species is fairly plentiful so that there is a chance that it will keep the pest within bounds, especially as the former does not appear to suffer from any hyper-parasite.

As the result of a series of investigations and experiments regarding certain phases of the life of the clearwing moth's larvæ, it was ascertained that they can and do work both up and down, or vice versa, in the tunnels made in the branches. The point of entrance is likewise that of exit. The larvæ were found capable of crawling over themselves, so to speak, in their narrow tunnels when wishful of changing the direction of burrowing. Whether a larva first commenced feeding down or up was found to be a mere matter of chance. Evidences were discovered of grubs feeding downwards until they came to an obstruction, then having slightly enlarged the feeding cavity, turned round (end for end, in common parlance) and fed upwards beyond the point of entrance, until a similar obstruction in the shape of woody pith had been met with. The enlarging and turning movements were then repeated and the larvæ found headed downwards and near the point where the exit would take place.

No official action has been taken by the Tasmanian Agricultural Department against the pest, but there is a likelihood of such being the case, if a general pests act now under consideration comes into force. The writer has recommended through the Press, the destruction of all badly affected currant bushes, vigorous pruning of bushes during the winter in affected plantations and destruction by fire of the parts cut away, care in selecting cuttings for striking, and the spraying of the bushes, immediately after the fruit has been picked, with arsenate of lead. These suggestions have been carried out by a number of growers with satisfactory results.

Rutherglen Fruit-Bug. The summer of 1916-17 was remarkable for the quantity of rain that fell intermittently all through. As a natural sequence there was a superabundance of plant growth, noxious and otherwise. The result was that pests of several kinds were more plentiful than in normal years. This was markedly so with regard to the Hemipterous bug, *Nysius vinitor*. The insect is indigenous to this State, and although it has been known to the writer to be yearly increasing in abundance, yet no complaints had been made by farmers or horticulturists with reference to damage committed. The Launceston Marine Board had an area of reclaimed land, adjoining one of the parks, on which a most luxuriant growth of all manner of noxious

weeds had been allowed to flourish. Early in the year it was found that the immature insects in countless myriads were migrating from the reclamation area onto the park in one direction, and along the gutters of the public streets in another. After some little delay on the part of the Government, steps were taken to isolate the breeding ground. Coal tar was spread round the edges where it did not join the park, and also in the gutters where the insects had traveled. The migration of further immature forms to the park was more or less prevented by spraying. The weeds on the area were cut and burnt. Nevertheless the measures were not sufficient to prevent a very large number of both mature and immature forms escaping. Unless the present winter proves severe, the writer fears that next spring will see the pest very plentiful over a wide area. Only two instances came under his notice where the insects caused damage, one person had the plants in his flower garden destroyed, and another lost his tomatoes. He has seen in Victoria (Australia) gardens destroyed, save for hardy shrubs, and soft fruits utterly ruined by this pest. Not only in many places in Victoria was the insect exceptionally plentiful last summer, but also in New South Wales. Potato crops suffered in addition to soft fruits, and flowering plants. Benzole emulsion as a spray, and smudge fires under the fruit-trees were found the most effective means of combating the insects.

CODLING MOTH. In Tasmania the codling moth (*Carpocapsa pomonella*) is single brooded, but the hatchings are extended over a long period. In some districts the larvæ are at work long before those in another make an appearance. Some years ago and before poison sprays had reached the pitch of excellence they now have, the pest was greatly feared and justly so, for the annual amount of damage was very great. Paris green was then almost solely used in conjunction with bandaging. Although a codling moth act was in force empowering heavy penalties to be inflicted for non-removal of bandages, and destruction of larvæ therein, etc., yet great carelessness and neglect were shown by many orchardists. Arsenate of lead has almost, if not quite, completely taken the place of Paris green, this together with a more intelligent system of spraying has reduced the codling moth to almost harmless proportions, and made the act as it now stands nearly obsolete. There are, of course, individual orchards where wormy fruit abounds, but they are the exception. The exhibition of such fruit for sale or contemplated sale in auction marts, or shops invariably leads to it being seized, and heavy penalties inflicted on the responsible parties.

Nearly every season as spraying time approaches discussions take place in the daily and weekly press regarding whether the first spray

should be made before the closing of the calyx lobes or not. Both sides have their advocates who can produce figures from their own orchards to prove or disprove one theory or the other. For some years past the writer has been collecting data from his own personal examination of apples and pears from several orchards concerning where the young larvæ enter. The averages deducted from some thousands of fruit examined show that 46 per cent were struck through the eye, 35 per cent at the base of the stalk, while for 19 per cent the mode of entry was through the side. In every instance the individual fruit was cut open in order to avoid any confusion between the entrance hole and that of exit. To my mind the above figures prove that the first spraying should take place prior to the closing of the calyx lobes, but that it should be followed by a second and a third application in order to render the fruit immune from the later hatching larvae.

THE COMMON EARWIG (*Forficula auricularia*) although causing a good deal of damage in flower gardens, and a certain amount in kitchen gardens, is capable of performing very meritorious work in the way of destroying codling moth larvæ under bandages. I have seen every larva that had gone to change into the pupal stage in a badly infested orchard eaten out. Nevertheless orchardists do not feel justified, and rightly so, in allowing earwigs to flourish.

HARLEQUIN FRUIT-BUG. In common with other Hemipterous insects the soldier bug or Harlequin fruit-bug (*Dindymus versicolor*) was excessively plentiful during the summer of 1916–17. The principal damage done by this pest is causing the berries of red, white, and black currants to fall before they are ripe. The fruit is punctured just at the bases of the stalks. Some of the softer varieties of apples are also treated in the same manner, causing disfiguring blemishes. During the period under review they turned their attentions to sunflower, and artichoke stems, after all the soft fruits were picked. In many instances the stems were so severely punctured that from the ground to the flower heads they were almost completely covered with knobby excrescences. Neither the sunflower heads, nor the artichoke tubers were in any way affected. All nectiferous flowers were continually covered with the insects in all stages of growth. Paling fences were favourite gathering places for the insects, clusters of many hundreds being a common sight. Boiling water was usually most effective in dealing with such swarms. Those on plants and flowers were dealt with by jarring into hot water, or water on which a film of oil had been spread. The swarming thousands of these brightly colored insects was a constant matter of comment, even by persons who usually are unobservant of insect life.

THE DEVELOPMENT OF A PORTABLE INSECTARY

By A. W. Young, *U. S. Bureau of Entomology, Melrose Highlands, Mass.*

In the spring of 1914 the entomologist in charge of the gipsy moth investigations for the Bureau of Entomology decided on a line of intimate field study in infested woodland at Lunenburg, Mass. As much of the experimental work was to be done under full control, some means of shelter was indispensable. An outer fly of a small tent was used the first season, but owing to the abnormal fluctuations in temperature and humidity under this, it was replaced the following year by a larger tent and fly, having its walls and ends covered with mosquito netting for the protection of the feeding trays, boxes and jars from outside interference. With slight modifications this tent served our purpose for three seasons, when it became necessary to renew many parts. The climatic data for previous years showed that we were carrying on delicate experimental work under conditions ten degrees above normal when the sun shone, so that the results were far from conclusive. It was determined to build an ideal shelter, as a result of four years practical experience. In order to fill our particular requirements this Insectary was built on the following principles: It must be strong, simple and portable, of sectional construction, made of non-conducting material with a continuous ventilating space from the eaves to ridge between the outer and inner walls.

This Insectary, 11 x 19 feet 7¾ inches, was set on 7 posts, had 1 front sill, 1 back sill, 2 door studs, 1 door head, 12 rafters, ridge pole, 6 rafter ties, 4 corner angle braces, 10 roof panels, 8 roof battens, saddle boards, 2 screens on each side set directly on the posts (without sills), 3 front screens and door and 2 back screens.

Materials used—in linear feet—158 ft. of 2 x 4 in. spruce, 126 ft. of 2 x 3 in. spruce, 164 ft. of ⅞ x 3 in. pine, 400 ft. of ⅞ x 2 in. pine, 20 ft. of ⅞ x 5 in. pine, 20 ft. of ⅞ x 6 in. pine, 41 ft. of ⅝ x 2½ in. pine batten, and 7 chestnut posts 3 ft. long and 6 in. in diameter. Bolts—26 2½-in., 10 3-in., 8 4-in., 33 6-in. Screws—14 2½-in., 50 ¾-in., one box of 1-in. brads, 8 lbs. of 2-in. wire nails with large heads, 90 ft. of 36-in. wire mosquito screening, 320 sq. ft. of heavy and 320 sq. ft. of medium weight wallboard; 4 gal. of white paint, 1 gal. of spar varnish, 2 spring hinges, and 1 door latch and lock. All lumber was planed on four sides for painting. All bolts were ¼-in. in diameter with two washers, one under the head and the other under the nut.

Seven chestnut posts were set, the tops of those at the corners were sawed 3½ in. square to allow for bolts each way, the two set at the center on the sides and the one under the door were sawed on one outer face only, all were cut 3½ in. deep or the thickness of the sills, which

rest on the shoulders so formed. Four sectional screen frames form the side walls, each built of 2 x 4 in. spruce, having two beams 9 ft. 9 in. long and three beams 3 ft. 5 in. long. The shorter beams are halved to the inner sides of each end and middle of the long beams and fastened together with 2½-in. bolts, forming a rigid frame to be covered as are all the other frames, with 36-in. wire mosquito netting. This is adjusted as follows: saw clear ⅞-in. pine boards of suitable length into 3/16-in. strips, plane and sandpaper on one side. Place one linear edge of the netting on the inner edge of the frame the long way, lapping on ¾ in. and fasten in place with a strip above mentioned, using a 1-in. brad every 3 in. to hold firmly, nail strip on the netting down the center beam; next nail strip opposite the first beginning at the center beam and nailing towards the ends to avoid pulling screening unevenly, pull netting taut by gripping outer edge with pinchers (as the width of netting required to cover with these measurements is 2 ft. 11 in. there will be a margin of 1 in. left outside the strip for pulling), nail the end strips last, being careful to allow 1 in. outside, this may be readily trimmed off with a sharp knife after nailing. The two end sills of 2 x 4 in. spruce are 11 ft. long, halved on to the lower projecting end of side screen, with ⅞ in. exposed for a base on which to rest the end screens. All of these are fastened with 6-in. bolts to the posts which were set so that the bottom of sills and side screens rest on the surface of the ground; these should be treated with creosote.

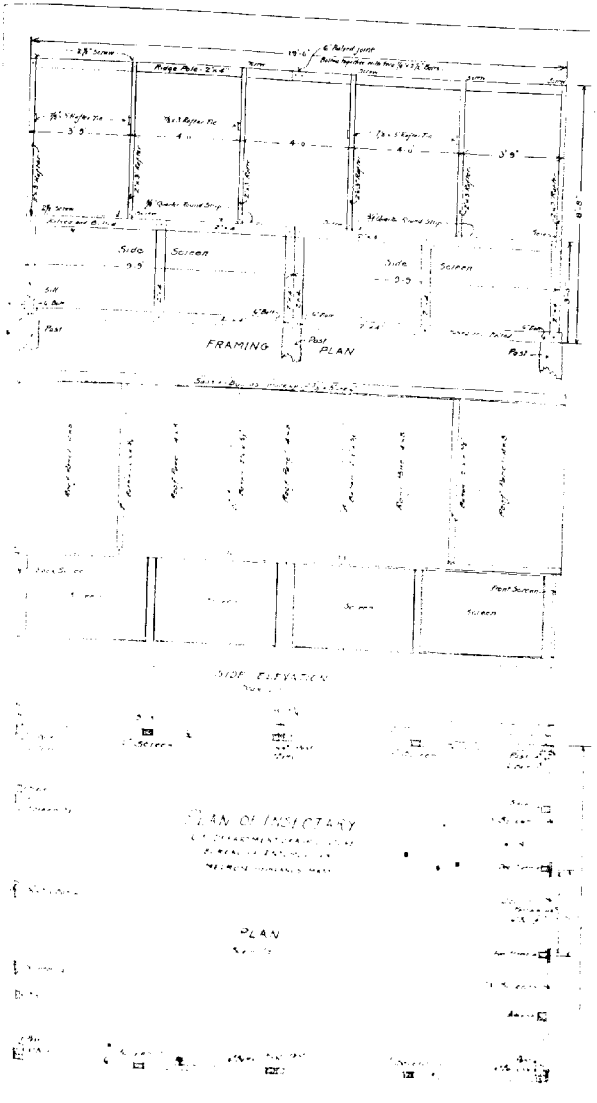
The floor is of earth or gravel. Fit 12 2 x 3 in. spruce rafters 7 ft. 7 in. long, the upper end sawed at the proper angle to adjust against the face of ridge pole with a 2½-in. screw, the end being exactly flush with the top. The lower end of the rafter should have a right angle notch cut so that one-third of the thickness of the rafter will bear against the vertical side of screen and two-thirds will rest on the top, to give greater thickness for holding a 2½-in. screw inserted in the counter-sunk hole passing through the end of rafter into top of screen. In locations where extra strength is not required, because of mild climate, protected situation, or the short period during which the Insectary is set up in any one place, the rafters may be omitted entirely by using strips of 2 x 2 in. in place of the ⅞ x 2 in. stock for the two joists forming the outer sides of each panel frame; the roof panel being held in place by a bolt at the ridge and one on each side inserted into the top of side screen.

The ridge should be beveled at the proper angle to make the surface of the panel fit closely. In case rafters are not used the interior ties for preventing the spread of the roof should be of 2 x 3 in. spruce and fastened to it by a bolt passing through an iron cleat 1 x 3 in. and ¼ in. thick (in place of upper washer), down between the abutting sides of

panels and diagonally through the end of the rafter tie, with a washer and nut on the inner side. Fit the ridge pole of two beams of 2 x 4 in. spruce 10 ft. long, to be halved together by a 6 in. splice fastened by two 2½-in. bolts. Fit four corner angle braces of 2 x 3 in. spruce 3 ft. 5 in. long, halved on lower end for fastening to sill with 4-in. bolt, the upper end to be cut at the proper angle to fit against side screen and fastened by 4-in. bolt with its head on outer side of screen. Set the end rafters flush with the end of side screens and end of ridge pole; set the intervening eight rafters at such points that the abutting edges of two roof panels will meet on the center of each rafter. Fit the door frame on the center of front sill, of 2 x 3 in. spruce 6 ft. 7 in. long, the lower ends halved on to the inner face of sill; the upper ends halved into the door head of 2 x 3 in. spruce 3 ft. 10 in. long, the ends of door head cut at an angle to fit against the under surface of the rafters and fastened by 2½-in. screws. Fit the rafter ties of ⅞ x 3 in. spruce or pine, 4 ft. 9 in. long, with the ends cut at the angle of the top of the rafters. These are fastened by 3-in. bolts, at the same level as the door head forming the top of door frame, to the face of each of the remaining pairs of rafters. No supporting posts under the ridge are required as the whole roof is trussed.

The roof is covered by ten panels 4 x 8 ft., the frame of each is built of four strips of pine ⅞ x 2 in. and 7 ft. 6¼ in. long, set up edgewise; to the ends nail a strip ⅞ x 2 in. and 4 ft. long; the end pieces have nine ¾-in. holes to allow ventilation from eaves to ridge between an outer and inner single sheet (4 x 8 ft.) of wallboard nailed to each side of the frame. Heavy ¼-in. stock should be used for the outer surface while the next thinner grade will answer for the inside; this wallboard is fastened with 2-in. wire nails having broad, flat heads, driving one every six inches around the outer edge of frame and one every twelve inches into the two interior stringers. Eight strips of pine batten ⅝ x 2½ in. are required. Each one has a groove ½ in. wide x ¼ in. deep, cut ½ in. from the edge of strip, and is nailed to one edge of a panel on the upper side, its center being over the joint formed by two abutting panels. On the opposite upper side is fastened a bead ⅜ in. wide and ¼ in. high, with 1-in. brads in such a place as to fit into the corresponding groove on the next panel for the purpose of preventing the rain from beating under the batten and down between the abutting panels.

The roof panels are fastened in place by two 6-in. bolts in each, one in the center of the top through the panel and diagonally through the ridge pole, and one through the side of frame and rafter, two feet from the bottom. These panels and building frame are covered with two coats of white paint with the addition of a coat of spar varnish on the outside of roof. The saddle boards are made up of ⅞ x 5 and 6 in. pine,



Plan of Field Insectary

nailed together at right angles, this is held in place by a screw into each panel; extra ventilation may be had by allowing the battens to extend under the saddle boards, raising the latter a little from the panels. The front and back screens and door are of $\frac{7}{8}$ x 3 in. pine, halved and fastened together at each union by two $\frac{3}{4}$-in. screws.

The door is 6 ft. $2\frac{1}{2}$ in. x 2 ft. $9\frac{1}{2}$ in. with one horizontal cross tie. The two front side screens are 6 ft. $2\frac{1}{2}$ in. on side next the door; 4 ft. $1\frac{1}{2}$ in. base; 3 ft. $1\frac{1}{2}$ in. on outside vertical edge; 4 ft. $4\frac{1}{2}$ in. on oblique edge, flush with the top of rafter, and $11\frac{1}{2}$ in. on top; each has one horizontal cross tie at the same height as the door. The triangular screen over the door is 4 ft. $8\frac{1}{2}$ in. at the base, and 3 ft. $3\frac{1}{4}$ in. on the oblique sides, which are also flush with the top of the rafter. The two back screens are 8 ft. 5 in. on their longest vertical, 3 ft. $1\frac{1}{2}$ in. on outside vertical, 5 ft. 6 in. on base, 7 ft. 8 in. on the top oblique edge flush with the top of rafter, the joint at the abutting edges under the ridge is covered by a $\frac{5}{8}$ x $2\frac{1}{2}$ in. batten.

The interior may be arranged to suit the needs of the investigation. We found that benches 30 in. wide and 28 in. from the bottom of the sill, along both sides and rear end, also a narrow hanging shelf 16 in. wide, set on a level with the top of side screen and supported by brackets fastened to each rafter, made a very convenient arrangement. The benches were of the heavier wallboard laid on a suitable frame.

The approximate cost of this Insectary was as follows: Wallboard, $55; lumber and hardware, $25; paint and varnish, $20. A carpenter and one assistant should build this structure in six days.

We have found this Insectary thoroughly practical, solving our problem for maintaining normal climatic conditions under full control, which is a first requisite for the development of delicate experimental work.

The writer is very grateful to Mr. A. F. Burgess, entomologist in charge, for enthusiastic support and encouragement, and to many of the assistants of the Bureau at the Gipsy Moth Laboratory for helpful suggestions. Among these special credit is due Mr. H. A. Preston for preparing photographs, Mr. Irving T. Guild for drafting plans, and to Mr. J. V. Schaffner, Jr., and E. R. Sturges who assisted in planning and construction work.

A drawing showing the details of construction is reproduced as plate 17 and a blueprint can be furnished to anyone desiring to build an Insectary of this sort.

Scientific Notes

A Suggestion for Tagging Trees. A note by Mr. F. C. Craighead in the June letter of the Bureau of Entomology on the use of the ordinary linen frank tag for labeling trees, leads me to suggest another form of tag that is good for this purpose. In marking fruit-trees in which wood-boring larvæ are working it is sometimes necessary to use labels that will remain legible for five years or more. For this purpose I have found nothing equal to zinc tags marked with a soft lead pencil. Sheet zinc is cut into tags of the size required, the tags perforated and attached to the trees with copper wire. It is easy to write on the zinc with a soft lead pencil and the writing lasts for a long while. I have tags of this kind that have been hanging on trees for fourteen years and the pencil markings on most of them are still distinct.

FRED E. BROOKS.

Flies Associated with a Grasshopper Outbreak. Bombyllid flies were noticed in great abundance during the first two weeks of September, 1918, in parts of Lassen and Sierra Counties, California, where grasshoppers have been very plentiful for the last two years. A species of Anthrax, near Alpha, was especially noticeable in the vicinity of Loyalton and in these regions grasshoppers had not caused the injury that they had in other parts of Lassen County. In one alfalfa field the constant humming of the flies annoyed the horses so that cutting was considerably hindered, the flies evidently being mistaken for bees. In this same region a similar outbreak of Bombyllids, although a different species, was recorded by C. V. Riley in the "American Naturalist," June, 1881. At this time, it is stated, an outbreak of grasshoppers lasting three years was largely checked by the work of these flies in the larval stage on the grasshopper eggs.

E. RALPH DE ONG.

Insect Pests of the Castor Bean. Castor beans, grown this year for the first time in quantities throughout the state of California, are being adopted as host plants by our common insects. Reports have come in from the northern part of the state of an unidentified cutworm attacking the young seedlings and in the south a species of Blapstinus caused serious damage by feeding on the stems of the young plants at the surface of the ground. This manner of attack by a species of Blapstinus is common in California on newly set tomatoes. In the overflow lands near Sacramento, the larva of *Laphygma flavimaculatus* (Harv.), commonly known as the beet army worm, attacked the leaves of plants in the blooming stage. The young caterpillars fed beneath a protecting web on the upper surface of the leaf, the attack usually beginning at the point of attachment to the stem. This was apparently the second brood of the year as moths bred from these caterpillars are ovipositing in September.

E. RALPH DE ONG.

The Common Cricket, Gryllus assimilis, as a Cotton Seed Pest. Early in September the reporters were sent to a large plantation at Dereon in the Mississippi delta to investigate a serious outbreak of something, thought possibly to be the Pink bollworm, damaging cotton seed in the newly opened bolls.

Nothing was found at work on the bolls during the day, but an investigation at night with the aid of electric flash-lights revealed the large black ground cricket, *Gryllus assimilis* Fab., variety *luctuosus* Serv., determined by Mr. Wm. T. Davis, in the act of combing away the lint from the upper seeds in the newly opened bolls, cutting away the seed hull and eating out the contents.

The particularly dry season in that section this summer and the consequent sparsity of vegetation usually fed upon by the crickets may have driven them to this new food material. Crickets are also reported to be unusually abundant there this year.

The upper seed in one or more of the carpels or bolls on the plants was eaten out. In cotton fallen on the ground, all seeds were damaged in this way. It was estimated that 10 per cent or more of the seed were thus destroyed. Small fragments of hulls which become embedded in the lint surrounding the seed, and which can not be ginned out, will cause a marked reduction in its grade.

The damaged bolls are very conspicuous. The hollow empty half hulls of the seeds show up dark against the lint. Particles of the seed content and hull spread about on and among the surrounding lint give it a charred appearance.

O. I. SNAPP,
E. W. STAFFORD.

Sugar-Cane Borer (*Diatræa saccharalis*). Early stages. The larva and pupa of this species show the key characters of the Galleriinæ rather than Crambinæ in Fracker's and Miss Mosher's keys. (Fracker, S. B., Ill. Biol. Mon. II: 1, p. 87; Mosher, E. Bull. Ill. St. Lab. N. H. XII: 2, p. 72.) They may be distinguished from the Galleriinæ as follows: In the larva setæ iv and v (kappa and eta of Fracker) are almost vertically placed on their common tubercle, and the hooks on the inner side of the prolegs are also of three lengths. The pupa has the short tongue and rudimentary pilifer of the Galleriinæ, but is easily separated by the slender form, suited to a boring species that pupates in its burrow, and by the body sculpture, which is of sharp raised reticulations, rising here and there into pyramidal points. The larva may be distinguished from that of Chilo, which has similar habits, by the complete circle of hooks on the prolegs. The pupa of Chilo is unknown to me.

W. T. M. FORBES, *Ithaca, N. Y.*

Injury to Hogs Resulting from Cocoon Eating. The following article is an abstract of a paper published in the "Journal of the American Veterinary Medical Association," by Dr. F. M. Hayes, Veterinary Surgeon of the University of California. Permission was kindly granted by Dr. Hayes for publishing same in the JOURNAL OF ECONOMIC ENTOMOLOGY so as to give greater publicity to this matter.

In June, 1918, Dr. F. M. Hayes, Veterinary Surgeon of the University of California was called to investigate a disease of hogs which had been ranging in oak timber in one of the coast counties of California. He writes in part as follows: ". . . from the two ranches reporting trouble thirty hogs out of eighty-two had died and the remainder of the herds were showing symptoms of disorder.

"The most prominent symptom noted was defaecation of long strings of feces. This was accompanied by severe straining which resulted in many cases in leaving a trail of several inches of feces still attached to the hog. An autopsy performed upon a pig showing symptoms of abdominal distress revealed an undigested mass continuous from the stomach to the anus. A dissection of this material showed it to be largely composed of a fine, wool-like fiber enmeshing bits of grass, barley hulls, and small fragments of a dark brown material. . . .

"On examining the range, the cocoons of tent caterpillars were found in great abundance scattered about on low plants and on oak leaves. Some of the oaks were practically defoliated, many caterpillars still being in evidence. The owner stated that this was the severest outbreak of caterpillars he had seen in ten years' residence there.

"On examination of the cocoon, the fiber was found to be identical with that found in the intestines, the dark brown fragments in the mass mentioned above proved to be masticated pupæ. Cocoons when thrown to the hogs were consumed readily, especially by the younger animals showing that they had acquired a decided appetite for this type of food.

"No treatment was advised other than to keep the hogs away from the infested

range until the moths had emerged. The majority of the affected animals recovered under this treatment. The older hogs either had not acquired a liking for the juicy pupæ or were better able to take care of the indigestable silk fibre of the cocoon."

The above article reveals an interesting result from an outbreak of *Malacosoma disstria* (Hub.), examples of which are not uncommon. Tent caterpillars have been unusually abundant in the coast counties this year but the above record is the only one reported of injury to grazing stock.

E. RALPH DE ONG.

Gracillaria zachrysa Meyr., attacks Apple Foliage in Northwestern India. The following letter has been received from Mr. T. Bainbrigge Fletcher, Imperial Entomologist, Agricultural Research Institute, Pusa, Bihar, India, dated July 31, 1918:

Dear Doctor Howard:

"In the Proceedings of our Second Entomological Meeting (p. 248) I have referred to a Gracillariad caterpillar attacking apple leaves in Northwestern India. We were able to obtain moths later on and I have now received its identification by Mr. Meyrick as *Gracillaria zachrysa* Meyr. As I note that this insect has lately been imported into the states on Azaleas from Japan via Holland, I think it is as well to let you know this at once in case it should become acclimatized and turn its attention to apples with you also.

"The same or a very similar species (specimens have only emerged today and I cannot compare them critically until they are off the setting boards) is also common on apple at Shillong, in Assam (N. E. India) so that it seems possible that this insect occurs in all the apple growing districts along the Himalayan region and, as these localities have mostly a very hard winter, there is the less reason why *G. zachrysa* should find difficulty in acclimatizing itself in the states. At present I gather (ENTOM. NEWS, XXIX, 114) that it is chiefly a greenhouse pest."

Under date of August 2, 1918, Mr. Fletcher adds:

"In continuation of my letter of July 31, I have now examined the adult of apple Gracillariad from Shillong (Assam) and make it to be *G. zachrysa*, as supposed, the Assam species agreeing exactly with others from N. W. India named by Meyrick."

Mr. Fletcher's communications will be of decided interest to American entomologists in view of the establishment of this insect in the United States.

L. O. HOWARD.

Caribou Warble Grubs Edible. There is an interesting reference in the October 1918 *Ottawa Naturalist* by R. M. Anderson to the edibility of caribou warble grubs. He states that the Eskimos pick out the grubs from the hides in the spring and eat them like cherries and adds, apparently from experience, that they are very watery and absolutely tasteless. This is not so very different from the report of some months ago upon the "white grub sandwich," only fewer "trimmings" appear to be necessary.

E. P. FELT.

JOURNAL OF ECONOMIC ENTOMOLOGY

OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

DECEMBER, 1918

The editors will thankfully receive news items and other matter likely to be of interest to subscribers. Papers will be published, so far as possible, in the order of reception. All extended contributions, at least, should be in the hands of the editor the first of the month preceding publication. Contributors are requested to supply electrotypes for the larger illustrations so far as possible. Photo-engraving may be obtained by authors at cost. The receipt of all papers will be acknowledged.—Eds.

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The readjustments of peace are facing the country. The urgent need for increased production must continue for some time and in this, as during the last two seasons, the practical entomologist must continue to play an important part. The same need for a close watch upon insect development in the field with the special purpose of anticipating and preventing serious injury must continue. The call for discrimination between the serious pest and the comparatively trivial is hardly less urgent, and here, as well as in many other fields, the applied entomologist will find much that can not be done by others. It is real service to the country. It is one of the best opportunities to demonstrate the practical value of economic entomology.

The war has stimulated investigations into the bionomics of various camp pests. There have been great additions to our knowledge of these pernicious forms and methods have been developed which will prove of great service in controlling insects under field conditions. Many of these investigations have not been completed and it is important that they be brought to a successful conclusion as far as possible, since knowledge of this character is not only of great value in time of conflict but it is essential to the successful handling of problems where sanitary ideals are still primitive. We need every advantage bestowed by a knowledge of disease carrying insects if we would live up to our opportunities.

The end of the war shifts the emphasis to be placed upon insects and their part in carrying disease, though it is none the less important. The battlefield and camp problems are less urgent. Conditions in the

war stricken areas are favorable to the spread of disease. Various infections have been widely distributed as a result of the wholesale movement and dissemination of troops and with entire nations suffering from malnutrition, conditions will be almost ideal for extensive epidemics when warm weather permits insects to become, once more, active carriers of disease. The control of the situation is rendered more difficult by the great reduction in man power. This makes it almost impossible to approximate the none too sanitary prewar conditions in a number of European countries. The seriousness of the situation is shown by the developments following earlier conflicts. Dr. Prinzing in his "Epidemics Resulting from Wars" has brought together evidence showing that "the most serious human cost of war has been not losses in the field, nor even the losses from disease in the armies, but the losses from epidemics disseminated among the civil populations." He points out that it was "the war epidemics and their sequelæ, rather than military losses, that accounted for the deep prostration of Germany after the Thirty Years' War. Such epidemics were also the gravest consequence of the Napoleonic Wars." Shall we allow these results to follow this world war? Recent investigations show that the control of insect borne diseases is not wholly a medical problem. The checking of the carriers is entomological work. The European situation offers unexampled opportunities for economic entomologists and sanitarians to coöperate effectively in saving these well nigh helpless peoples from the logical outcome of this fearful struggle. It is conservation of human lives and man power at the very time when such is most urgently needed in the rehabilitation of nations.

OBITUARY

FREDERICK KNAB

November 2, 1918. Word has just come that Mr. Frederick Knab, entomological assistant in the Bureau of Entomology, and, since the death of Mr. Coquillett, honorary custodian of the Diptera in the National Museum, has died. Mr. Knab first entered the Bureau in April, 1906, and during his twelve years' work with us gained a very high rank. His scientific work was of the highest character; his reading was broad, and was facilitated by his knowledge of several foreign languages. He had traveled extensively in his earlier years, and, in fact, while in Brazil some time before he came to the Bureau he probably contracted the obscure disease that eventually ended his life. He was not incapacitated for work, however, until comparatively recently, and during the whole period in which the disease remained

dormant and slowly progressed, his researches on disease-bearing insects, and especially on mosquitoes, made him one of the foremost workers in this field. He was an artist of very unusual ability, as is especially shown by the wonderful illustrations of mosquito larvæ reproduced in the Carnegie Institution Monograph of the Mosquitoes of North and Central America and the West Indies and which, in fact, reached the summit of beauty and perfection. His training in art was received as a young man in Dresden. L. O. H.

EVERETT JAY VOSLER

EVERETT J. VOSLER, foreign collector for the Insectary Division of the California State Commission of Horticulture, died on November 7th, at Fort Rosecrans, San Diego, Cal., of pneumonia following influenza.

Mr. Vosler was born on July 13, 1890, at Fort Collins, Colo. After attending high school there he entered the Colorado Agricultural College from which he was graduated in 1911. He specialized in horticulture and entomology and made an enviable record as a student, although he carried on a great deal of outside work while pursuing his studies. He was also prominent in athletics, winning the college championship in tennis and being a member of the baseball team.

In 1911, after finishing his college course, he entered the service of the United States Department of Agriculture as an expert in the Bureau of Entomology, section of cereal and forage insect investigations. He was assigned to work on the alfalfa weevil problem at Salt Lake City, Utah. Here he remained until the spring of 1913 when he accepted a position as assistant superintendent of the California State Insectary. In September, 1914, he was promoted to the secretaryship of the Commission which included the editorship of the *Monthly Bulletin*. In January, 1917, he was, on account of his success in handling living insects, made foreign collector of the Insectary Division and sent to Australia to collect beneficial insects. He brought back to this country a number of promising species of parasites and predators, particularly on mealybugs and black scale.

Upon his return he made every exertion to get his work in such shape that he could enlist in the army, waiving all claims to exemption, which was offered him. He joined the 25th Artillery at Fort Rosecrans, only a few days after which he was stricken with the malady from which he never recovered.

Mr. Vosler was well informed in horticulture as well as entomology, and was an unusually successful grower of chrysanthemums. While he was not a voluminous writer, his great energy and thoroughness enabled him to accomplish a great deal of work on the life-histories of

insects, the results of which are contained in his notes filed at the State Insectary. He was very fond of out-door sports and played, as he worked, with all the energy at his command.

His death is not only a loss to the profession but is a deep personal one to his many friends and we all are better men for having associated with him.

HARRY S. SMITH.

Review

The Insect and Related Pests of Egypt. Vol. 1, The Insect and Related Pests Injurious to the Cotton Plant. Part 1, The Pink Bollworm, by F. C. WILLCOCKS. Sultanic Agric. Soc., quarto, 339 pages, 17 text figures and 10 plates, 4 colored. 1916.

This work deals with a very exhaustive investigation of the insect pest which is now attracting very great attention in most of the cotton producing countries of the world, and which threatens to become established in the United States. It is a most welcome publication on account of its timeliness and on account of the painstaking work upon which it is evidently based. It is most fortunate for the cotton producers of the world that it has been possible under the difficulties of the present time to publish the work in such full and commendable form.

The work covers all phases of the pink boll-worm problem in Egypt, including the history and origin of the infestation, the nature and amount of the losses, food plants, life history (in the broadest sense), natural enemies and means of control.

The thoroughness of the work is indicated by the number of individual observations on points in the life history of the pest. In most cases scores or hundreds of observations were made on such points as the duration of the stages. The form and amount of damage under various conditions is indicated by equally numerous observations.

The author shows that the pink bollworm was introduced in Egypt about 1906, at which time there was a very great increase in the amount of Indian cotton imported into that country. There was a very high proportion of seed left in the Indian consignments. The view is held that India is undoubtedly the original home of the pest.

American entomologists will be especially interested in the author's remarks regarding the possibility of the adaptation of the pink bollworm to the conditions existing in the United States. The following are his remarks on this subject:

"If the pink bollworm once gained a footing in the Southern States it would stand a good chance of becoming firmly established and might well prove to be as serious a pest to cotton as the notorious Mexican cottonboll weevil.

"The climate being suitable for commercial cotton growing, there seems no particular reason or reasons to doubt that it would not also be favorable to *Gelechia gossypiella*. It is true that frosts occur in some parts of the cotton growing belt; but nothing approaching sufficient severity to seriously inconvenience this species would be experienced, since this insect appears to be particularly resistant or adaptable to both heat and cold."

A very careful analysis of the statistics of production of cotton in Egypt, together with records of studies in individual fields, leads the author to the conclusion that in 1914 there was a loss of approximately one hundred pounds of seed cotton per acre. This is said to represent from 21 to 27 per cent of the crop.

Several new points connected with the life history of the insect are brought out. Among these is the spinning of a web by the first stage larva in many cases, under which it works while boring its way through the carpel of the boll. The statement is also made that the pink bollworm has been observed to injure the stem of cotton plants. At one of the experimental farms a number of plants had broken off about six inches above the ground. Examinations showed that at the break the stem had been completely girdled, and the culprit was found to be the pink bollworm. The feeding of the larva in the blooms, which has been referred to only casually by other writers, is dealt with fully. In many cases the larva works in the pollen where it spins a protecting membrane and pupates. This habit has recently been observed in Mexico, but the Mexican observations have not been published. Of equal interest are the exact data regarding the location of the eggs on the cotton plant. In an examination of twenty-five plants a total of fifty-nine eggs were found. Of these 62 per cent were on small leaves at growing points and about the squares, 12 per cent on large leaves, 10 per cent on squares, 12 per cent on bolls and 3 per cent on the bracts of squares and bolls.

The author found that moths would emerge after a resting larval stage of twenty months. Only 28 per cent of the larvae were killed by sixty-nine hours submergence in water.

Control measures are treated exhaustively, but they are largely peculiar to Egyptian conditions and will not be dealt with here.

The author has made one of the most important contributions to entomological science which has been presented for several years. He is to be congratulated on the work he has done, and it is to be hoped that the appearance of the remaining portion of the volume and of other possible volumes may not be long delayed.

W. D. HUNTER,
Bureau of Entomology.

Current Notes

Mr. Henry L. Viereck of the Bureau of Biological Survey, was married, October 24, to Ella Adele Pearce Davis of Washington, D. C.

Mr. Walter W. Marshall, formerly instructor in zoölogy, University of Minnesota, died October 1, at Camp Sherman, Ohio, while attached to the Base Hospital.

Mr. Frank C. Pellett, for five years state apiarist of Iowa, has recently become associate editor of the American Bee Journal, and his address is now Hamilton, Ill.

Major General William C. Gorgas has been made a grand officer of the Order of the Crown of Italy, in recognition of his distinguished services in behalf of military sanitation.

The degree of doctor of laws has been conferred on Dr. Arthur E. Shipley by the University of Michigan. Dr. Shipley is a member of the British Educational Mission to the United States.

Transfers in the Bureau of Entomology have been made recently as follows: Oscar Bäker, Texas, to the Office of Markets; Carl Heinrich, Forest Entomology, temporarily to the Federal Horticultural Board for the study of the pink bollworm.

Prof. E. Dwight Sanderson, formerly entomologist at the Delaware, Texas and New Hampshire stations and director of the New Hampshire and West Virginia stations, who has been engaged in special work in the Office of Extension Work, North and

West, U. S. Department of Agriculture, since last February, has been elected professor of Rural Organization in the New York State College of Agriculture at Cornell University.

Dr. Arthur Everett Shipley, the well-known zoölogist and vice-chancellor of the University of Cambridge is now in the United States as head of a commission to secure closer coöperation between American and British educational institutions.

Dr. A. C. Chandler, assistant in zoölogy, and F. H. Lathrop, research assistant in entomology, Oregon Agricultural College, have received commissions as second lieutenants in the Sanitary Corps, and have been granted leave of absence from their college work for the duration of the war.

Dr. E. D. Ball, state entomologist of Wisconsin, took up his work as chairman of the Department of Zoölogy and Entomology at the Iowa State College, Ames, on October 20. He will also be chief of the Entomological Department of the Experiment Station and state entomologist.

Prof. C. L. Metcalf, assistant professor of economic entomology at the Ohio State University, Columbus, Ohio, has been granted a leave of absence for the entire year and is engaged in graduate study at the Bussey Institution of Harvard University, Forest Hills, Mass. He is specializing in the dipterous family Syrphidæ.

According to Science Professor Maxwell-LeFroy, professor of entomology at the Imperial College of Science, London, has accepted a year's engagement with the Commonwealth Government for £3,000, plus £2,000 for experiments. He will investigate the blowfly, the grain weevil, the woolly aphis, prickly pear and St. Johnswort.

Mr. V. E. A. Daecke, assistant in the Bureau of Zoölogy, Department of Agriculture, Harrisburg, Pa., died at Richmond, Long Island, N. Y., October 27. Mr. Daecke was a specialist in the Diptera, and a member of the Entomological Society of America, the Academy of Natural Sciences of Philadelphia, and a fellow of the Harrisburg Natural History Society.

Harold Morrison, Bureau of Entomology, has left for tropical insect work, and plans to cover such of the Islands of the Lesser Antilles as are of sufficient commercial or agricultural importance to justify an entomological survey. The field will extend from the Virgin Islands south to Trinidad and may also include British Guiana and other portions of the northern coast of South America.

Experimental work with the Smith machine at Philadelphia by the Bureau of Entomology has demonstrated that bean weevils, rice weevils, and the Angoumis grain moth can be killed by passing the infested seed through an electrical field. It remains to be seen whether the inventor can make good his belief that he can kill insects in grains and other seeds passed through a machine at the rate of 200 to 300 tons per hour. While this machine has yet to be perfected, it promises much.

The following appointments are announced by the Bureau of Entomology: Mr. Arthur E. Mallory, Kansas State University, scientific assistant, truck crop insects, Greeley, Colo.; Miss Anna R. Frank, Los Angeles, Calif., scientific assistant, Southern field crop insects, for duty at Washington, D. C.; Lloyd P. O'Dowd, field assistant, sugar-cane insect laboratory, New Orleans, La.; L. R. Watson, extension work in bee culture, Storrs, Conn.; H. A. Scullen, apicultural extension work in Washington, Oregon, Montana and Northern Idaho; H. L. McMurray, apicultural

extension work in Wisconsin and Minnesota; W. A. Smith, apicultural extension work in Georgia.

A conference on the Oriental Peach Moth, *Laspeyresia molesta* was held at the Bureau of Entomology, Washington, D. C., November 12, at 10 o'clock a. m. The distribution, life history, injury, danger of spread and quarantine possibilities were discussed. The danger of spread by means of shipped fruit was considered far greater than by means of nursery stock, and any quarantine should include both. It was thought best not to establish any Federal quarantine at present. The following were present: Messrs. C. L. Marlatt, A. L. Quaintance, E. R. Sasscer, W. B. Wood, Bureau of Entomology; R. C. Althouse, Federal Horticultural Board; T. B. Symons, E. N. Cory, Philip Garman, Maryland; J. G. Sanders, Mr. Hoopes, Pennsylvania; T. J. Headlee, New Jersey; Wesley Webb, Delaware; Geo. G. Atwood, New York; W. E. Britton, Connecticut; W. E. Rumsey, West Virginia; L. A. Stearns, Mr. Underhill, Virginia.

The following resignations are reported from the Bureau of Entomology: Miss Edith M. Brace, scientific assistant, Southern field crop insects, to return to teaching in New York City for the winter; J. P. Landry, truck crop insects, Louisiana, to enter the army; J. W. Sauer, truck crop insects, Kingsville, Texas, to resume his educational work; Victor Duran, truck crop insects, Alhambra, Calif., to enter the army; G. J. Hucker, cereal and forage insects, Nebraska, to enter military service in the Sanitary Corps; J. M. Langston, cereal and forage insects, Forest Grove, Ore., to engage in state work in Mississippi; Miss Mabel Stehle, scientific assistant, truck crop insects, to accept an appointment as instructor in zoölogy at Clemson College, S. C.; deciduous fruit insect investigations as follows: W. D. Whitcomb, J. H. Boyd, H. E. Spaulding, J. N. Lowe, D. R. Royder, to enter the army; M. B. Boyd, A. E. Booth, to enter private business; H. B. Pierson, E. W. Babcock, Geo. H. Vansell, to reënter college; Frazier Rogers to accept a position as assistant professor of agronomy, University of Florida; K. E. Bragdon to resume his work with the Florida State Plant Board; C. H. Arndt to accept a fellowship in medicine; H. L. Weatherby to resume educational work in Savannah, Ga.; Max M. Reeher, cereal and forage insects, Forest Grove, Ore., has been granted an indefinite furlough to enter military service; H. M. Fort of the same division has entered the Medical Corps.

Mailed December 17, 1918.

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